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**GEOTECHNICAL DATA PACKAGE**  
**I-70 Connector Darling Spur MSE Wall Structure**  
**I-70 Tri-Level Connector Project**  
**FAI Route 70, Contract No.: 76C44**  
**Section No.:82-2-1HVB**  
**Proposed SN: 082-W234**  
**IDOT Job: D-98-059-08 (SPECIAL BULLETIN 890, ITEM 160)**  
**St. Clair County, Illinois**

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**JOB NO. 08201**  
**April 2010**



April 27, 2010

Teng and Associates, Inc.  
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Chicago, Illinois 60601

Attention: Mr. Bob Stern

Job No. 08201

Re: Darling Spur MSE Wall Geotechnical Data Package  
Interstate 70 Tri Level Connection, Mississippi River Bridge Project  
Proposed SN 082-W234  
FAI Route 70 (I-70), St. Clair County  
IDOT Job No. D-98-059-08, Special Bulletin 890, Item 160

Dear Mr. Stern:

The following report presents the geotechnical analysis for the Mississippi River Bridge (MRB) Darling Spur MSE Wall structure for the Interstate 70 (I-70) Connector, Mississippi River Bridge Project. A total of seventeen (17) soil borings (WB-01 through WB-13, WB-05A, WB-11A, SB-09 and SB-10) were completed at the site by Geo Services, Inc. (GSI). Copies of these boring logs, along with rock core information, are included in this report.

If there are any questions with regard to the information submitted in this report, or if we can be of further assistance to you in any way, please do not hesitate to contact us.

Very truly yours,

GEO SERVICES, INC.



Andrew J. Ptak, P.E.  
Office Manager



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Vice President



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enc.

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## **INTRODUCTION**

The following report presents the results of the geotechnical investigation performed for the proposed Darling Spur Mechanically Stabilized Earth (MSE) wall for the Interstate 70 (I-70) Tri Level Connection, Mississippi River Bridge Project. The project site is located just east of the east bridge abutment on the Illinois side of the proposed I-70 alignment. The proposed MSE wall is located near Industrial Avenue in St. Clair County, Illinois. This report is based upon information regarding the proposed improvement and subsurface information obtained in seventeen (17) soil borings (WB-01 through WB-13, WB-05A, WB-11A, SB-09 and SB-10). Copies of a location diagram, laboratory test results, the soil profile and the boring logs are included with this report.

Adjacent to the alignment of the proposed I-70 roadway is the Darling Spur Railroad Line; the Darling Spur is not to be relocated and will remain in its existing location. Approximately twenty to forty feet of embankment fill material is to be placed adjacent to the Darling Spur railroad track to the east of the proposed bridge abutment. Due to the close proximity to the Darling Spur Railroad Line and limited space provided for the Right-of-Way (ROW), an MSE wall is proposed to support the embankment fill.

This report refers to the portion of the project centering on the MSE wall. The proposed MSE wall is to start at the approximate station of 440+57 (I-70 station 140+66) and will end at the approximate station of 447+45 (I-70 station 147+35). Stations referenced in this report refer to the MSE wall baseline unless stated location is on I-70 baseline. The wall height will vary from approximately 35 feet (at station 440+57, I-70 station 140+66) to 15 feet (at station 447+00, I-70 station 146+90). The project location is shown on the site map included in Appendix A.

## **SUBSURFACE INVESTIGATION PROCEDURES**

The soil boring locations were selected by Geo Services based on the criteria in the IDOT Geotechnical Manual and submitted to and approved by Teng and IDOT. Reference stakes (stations, offsets and elevations) were laid out by representatives of the project surveyor, ABNA. Elevations of the borings are shown on the boring logs. The as-drilled locations for the borings and cores are shown on the Boring Location Diagram found in Appendix B.

The borings were performed during the period April 6<sup>th</sup> – 20<sup>th</sup> and July 21<sup>st</sup> – 29<sup>th</sup>, 2009 with an ATV mounted drill rig and the borings were advanced by means of continuous flight augers to a depth of 10 to 15 feet installing 4-in diameter casing and continued with rotary drilling techniques to completion. Representative samples from the drill rig were obtained employing split spoon sampling procedures in accordance with AASHTO T-206.

In addition, three (3) boreholes were drilled during September 17<sup>th</sup> – 23<sup>rd</sup>, 2009 and October 19<sup>th</sup> – 21<sup>st</sup>, 2009 for down-hole seismic analyses. WB-13, WB-05A and WB-11A were “blind drilled” to bedrock. Bedrock cores were then obtained using a NX-size double tubed core barrel with a diamond impregnated bit. Bedrock was cored to a minimum depth of 25 feet or until RQDs of approximately 90% were encountered. After drilling WB-13, PVC piping was installed in the borehole to allow for down-hole seismic testing, and the borehole annulus space was grouted. Geotechnology used WB-13 to perform their down-hole seismic testing. The report by Geotechnology can be found in Appendix I.

## **LAB TESTING PROGRAM**

The soil test procedures were performed in accordance with the procedures discussed in the Illinois Department of Transportation (IDOT) Geotechnical Manual. The results of the general soils testing program, along with a visual classification of the material based upon both the IDOT textural classification and an estimate of the AASHTO soil group classification system, are indicated on the boring logs. All split spoon soil samples obtained from the drilling operation were visually classified in the field and in the laboratory.

In addition to the regular lab testing program, Atterberg Limits (AASHTO T-89/90), Particle Size Analysis (AASHTO T-88) or Grain Size Analysis (AASHTO T-311) and Consolidated-Undrained Compressive Strength (AASHTO T-297) tests were performed on select samples from the borings. The tests were performed upon representative portions of the samples obtained in the field. The results are noted in the BD-508A forms located in Appendix F.

Bedrock cores were obtained using rotary drilling techniques and a NX-size double tubed solid core barrel with a diamond impregnated bit. Compressive strength testing was performed on representative rock core samples from the field. Testing was performed in accordance with (ASTM D7012), and the results can be found in Appendix F.

## **GEOLOGY**

The ISGS Berg Circular #532 indicates the project site is located in an AX Zone which is defined as an area with variable alluvium deposits which are in excess of 20.0-ft thick. The ISGS Circular #542 Stack Map indicates the project site is located in an area with in excess of 20.0-ft of Cahokia Alluvium soils at the surface that are underlain by more than 20.0-ft of Henry Formation soils and that bedrock is in excess of 50.0-ft deep. A review of the ISGS Digital Water Well records confirms that bedrock is in excess of 100-ft in this area. Cahokia Alluvium deposits generally consist of flood plain and channel deposits of present rivers and streams and contain silts, sands, some gravel and

organics. Henry Formation soils generally consist of sand & gravel with local beds of silt and ranges from coarse gravel to fine silty sand and is typically poorly sorted.

According to ISGS Circular 465 entitled "Geology for Planning in St. Clair County, IL", bedrock, which can be expected to be a St. Louis Limestone, should be encountered within an elevation range of 300 to 325 in this area. Plate 2: "Surficial Deposit Thickness" included in this Circular indicates that there is more than 100-ft of surficial alluvial and glacial deposits in this area. In the borings performed for this investigation, limestone bedrock was encountered in two (2) borings within a depth range of 106' to 113.5' below ground surface that corresponds to an elevation of approximately 299.0' to 300.0'.

According to the Wetland Inventory maps reviewed on-line at the US Fish & Wildlife Service website, there are no wetland areas identified within the limits of the retaining wall.

According to the USDA Natural Resources Conservation Service Soil Survey Data Base, surficial soils in the vicinity of the project site are associated with either a Gorham Silty Clay Loam, or Urban Land soils. The Gorham Silty Clay Loam is not considered to be overly organic (less than 4.0%) and potential frost action is rated as high.

According to ISGS Coal Mining Maps for Madison/St. Clair Counties, there has been no historical coal mining in near vicinity to the project site. The nearest documented coal mines are located approximately 9 miles to the east out of the Mississippi River Floodplain where bedrock is located at much shallower depths.

The available geologic information indicates that the subgrade soils within the limits of the project site should generally consist of granular alluvial deposits. This is consistent with the conditions encountered in this investigation except that thicker deposits of clay soils were encountered within the upper 8.0' to 13.0' than the referenced sources suggest should be present. Limestone bedrock was encountered in the deeper borings performed for this investigation at the approximate elevations indicated by the sources discussed above.

## **CLIMATIC CONDITIONS**

The climate within the area of this project falls within the temperate humid, continental range and is characterized by cold conditions in the winter and warm conditions in the summer. The winter average daily temperature is 31° F. The summer average temperature is 77° F and the summer average daily maximum temperature is 87° F. The total annual precipitation for this area is 36.8" with approximately 60% falling between April and September. The average seasonal snowfall for this area is 16.0".

Local Climatological Data, as reported by the National Oceanic and Atmospheric

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Administration (NOAA) for St. Louis, Mo. for the three (3) month period prior to and during each of the drilling events performed for this project, including total precipitation, average temperature and snowfall are summarized in Table 1.

**Table 1 – Climate Conditions**

MONTH-Yr	ppt (in)		Temp (°F)		Snow (in)	
	Total	Departure From Norm	Average Temp	Departure From Norm	Total	Departure From Norm
Jan-09	0.77	-1.37	28.9	-0.7	7.0	-0.4
Feb-09	2.33	0.05	39.0	3.6	0.1	-4.7
March-09	3.04	-0.56	49.3	3.5	1.8	-1.5
April-09	4.06	0.37	56.6	-0.6	0.1	-0.5
May-09	4.72	0.61	67.0	0.4	0.0	0.0
June-09	6.42	2.66	77.7	2.1	0.0	0.0
July-09	4.2	0.3	75.6	-4.6	0.0	0.0
August-09	2.48	-0.50	76.4	-1.8	0.0	0.0
September-09	3.16	0.20	69.8	-0.4	0.0	0.0
October-09	12.38	9.62	61.3	-7.0	0.0	0.0

**Borings performed 4-6-09 to 4-8-09 and 7-21-09 to 7-29-09**

Total precipitation in the three months preceding the first drilling event in April, 2009 was below normal and temperatures were above normal. Precipitation levels during the month of April, 2009, when the first drilling event was performed, were slightly higher than normal and temperatures were slightly below normal. Total precipitation during the three months prior to the second drilling event was higher than normal and temperatures were slightly above normal. Precipitation levels during the month of July, 2009, when the second drilling event was performed, were near normal and temperatures were significantly below normal. The climatic conditions encountered prior to and during drilling operations suggest that the soils should be less than normal moisture levels when the first drilling event was performed in April, 2009 and at or near normal levels during the second drilling event performed in July, 2009.

The month of August had lower temperature and slightly lower precipitation level. The month of September had slightly lower temperatures and slightly higher precipitation

levels. This would lead to slightly higher moisture contents in the soils and slightly lower strengths during the drilling activities for WB-13. The month of October experienced significantly lower temperatures and significantly higher precipitation levels. This would suggest that the soils for WB-05A and WB-11A would experience higher than normal moisture contents and lower than normal strengths.

## **SOIL AND GROUNDWATER CONDITIONS**

Specific soil conditions encountered in the borings are indicated on the soil boring logs and in the soil profiles. As indicated on the logs and profiles, surficial soils consisted of approximately 1 foot of topsoil overlying 5 feet of stiff silty clay (A-7) to an elevation of 400. Underlying the stiff silty clay is a 7-ft stratum of very soft to medium stiff silty clay (A-6 to A-7). From elevation 393 to 330, the soil strata were generally made up of medium dense to dense sands with isolated loose sand stratums. From 330 to 313, soils consisted of loose to medium dense sand with gravel with occasional dense to very dense sand strata. Below this material, dense to very dense sand and gravel soils were encountered before bedrock at an elevation of approximately 299. Bedrock consisted of Mississippian System, Valmeyeran Series Limestone. RQD values from boreholes WB-01 through WB-12 ranged from 16% to 60% with an average of 40%. The stratification lines shown on the boring logs represent the approximate boundary between soil types, and the actual transition may be gradual.

Additional explorations for bedrock were performed a few months after initial boreholes were drilled. WB-05A, WB-11A and WB-13 were "blind drilled" until reaching the top of bedrock, and had bedrock RQDs from 30% to 70% in the top ten feet of rock cores. WB-05A and WB-13 encountered higher RQDs (ranging from 80% to 100%) for the remaining 15 feet of rock core. WB-11 rock core RQDs, however, were in the range of 13% to 30% from 10 feet to 30 feet of rock core until encountering an RQD of 90% at an elevation of 270.

Water level readings were obtained in the borings during the drilling operation and these readings are shown on the boring logs. Due to rotary drilling techniques, groundwater levels were not able to be taken below a depth of 10 feet. When groundwater was encountered, it was noted during drilling operations at an approximate elevation of 397. In nearby borehole EB-05, a monitoring well has been installed which indicates water at an elevation 400. Borehole EB-05 has been included in Appendix F. Due to the stratum change from brown and gray to gray, we estimate the long-term groundwater table at an elevation of 338 to 370. Fluctuations in the amount of water accumulated and in the hydrostatic water table can be anticipated depending upon variations in precipitation and surface runoff.



## ANALYSIS

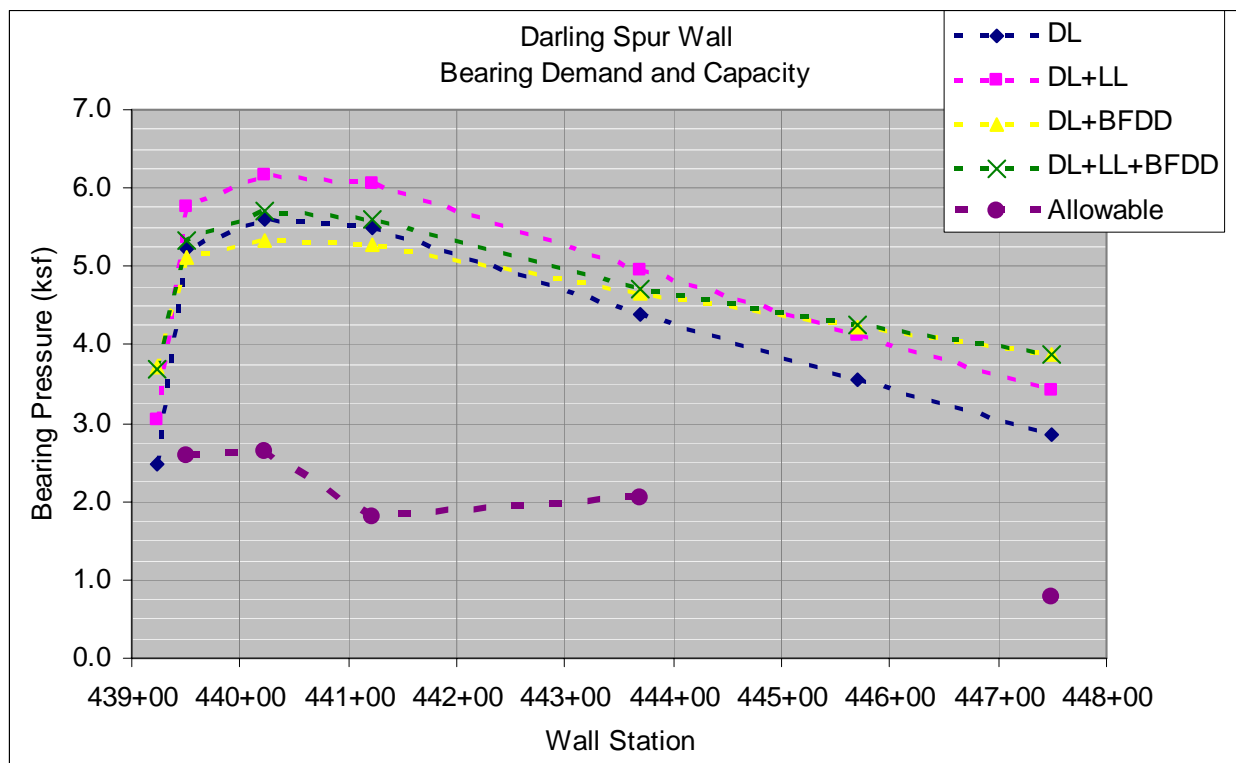
### Recommended Wall Type

The maximum wall height is proposed to be approximately 35 feet. The project is located in an area of considerable seismic activity and the soil profile indicates soft clay soils near the surface with deeper, potentially liquefiable stratum of sandy soils underlying the soft surficial clays. Considering this is a fill wall and not a cut area, we believe the MSE wall would be the more economical wall option.

### Bearing

Bearing pressure demands and existing soil capacities at several stations along the wall are summarized in Figure 1.

**Figure 1 – Bearing Demand and Capacity**



Bearing pressure demand has been calculated for four loading assumptions, illustrated and described in Figure 2.

**Figure 2 – Loading Diagrams**

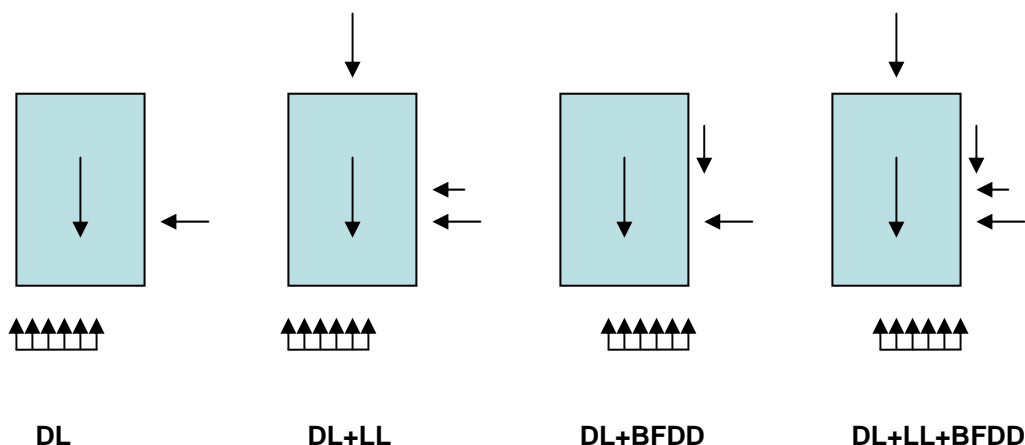


Illustration of static-equilibrium computation of an equivalent uniform bearing pressure demand. Forces act on the mass of reinforced soil of assumed proportions  $H \times 0.7 H$  where  $H$  = wall height, and the reinforced soil mass is treated as a rigid body. Four cases are shown:

- DL = dead loads and lateral earth pressure
- DL+LL = DL plus inclusion of 250 PSF LL surcharge
- DL+BFDD = DL plus inclusion of a back-face downdrag (see text)
- DL+LL+BFDD = all of the above effects.

Conditions 1 and 2 are the conventional retaining wall loading cases. Conditions 3 and 4 reflect an assumption that large settlements (see *Settlement* section) will be remediated and prevented at the MSE wall, but will be allowed to occur in the embankment behind the reinforced soil block. As a conservative check, it is assumed that this settlement could produce a downdrag load on the back face of the reinforced soil block of magnitude 750 pounds per square foot (psf) of adhesion stress created by the settling soils of the adjacent embankment. The value of 750 psf was determined by taking the assumed shear strength (stiff, cohesive soil) of the embankment and comparing the value to the adhesion values according to NAVFAC 7.2, Table 1. Depending on wall proportions, this downdrag can result in shifting of the equivalent uniform bearing pressure to the “heel side” of the wall.

The “Allowable Bearing” given in the chart reflects the nominal capacity based on soil boring logs and test data and the required safety factor of 2.5. According to the boring logs and the chart, the existing surficial 10 to 15 feet of soil consisting of soft clays and loose loams and sands do not possess the required strength and must be improved (or replaced) prior to the construction of the wall.

**Settlement**

The results of the calculated settlements are summarized in Table 2. Estimated total settlement and times to achieve 50% and 90% of total settlement are provided. According to the boring logs, indicating surficial soils consisting of soft clay and loose sand and loam stratum above an approximate elevation of 390, the settlement levels are not considered acceptable to IDOT requirements. We recommend that the ground improvements, which will be required for strength (bearing) concerns, also be utilized to reduce anticipated settlements within the reinforced soil zone.

**Table 2 – Summary of Settlement Analyses**

Station	439+50	440+23	441+23	443+70	447+50
Total Settlement	12"	14"	14"	7"	3"
Time to 50% (days)	70	80	80	40	10
Time to 90% (days)	300	360	360	160	30

**Stability**

The results of the slope stability analyses are summarized in Table 3. These are the conventional static stability checks treating the reinforced soil mass as a rigid block. Detailed results are provided in Appendix H. The required Factor of Safety (FS) for non seismic events is 1.5. As seen in the Table 3, factors of safety calculated have exceeded the value of 1.5.

**Table 3 – Summary of Static Slope Stability Analyses**

Global Static Slope Stability	Required Factor of Safety (FS)	Computed Factor of Safety of Wall at Station				
		439+50	440+23	441+23	443+70	447+50
Factor of Safety (FS)	1.5	1.5	1.5	2.0	3.0	2.0

**Seismic Considerations**

The project site is anticipated to be affected by seismic activity due its proximity to nearby geologic fault-lines. Following the General Method of the AASHTO LRFD Bridge Design Specification 2007 (with 2008 Interim) the project site is characterized by a horizontal peak acceleration of  $S_{D1} = 0.24g$  (period of 1.0 second and 5% critical dampening at ground surface), Site Class: D. AASHTO designates this condition with a Seismic Performance Zone = 2.

However, the subject wall and adjacent bridge structure are being designed by a modified seismic criteria and are utilizing a site-specific seismic hazard analysis. The criteria require checking the conventional 1000-year return period event and the 2500-year return period event. At each of these return periods, separate consideration is given to the events arising in the (far-field) New Madrid Seismic Zone and in the (near field) background source zone.

For the site specific analysis, shear wave velocity testing has been performed by Geotechnology at borehole WB-13, and Geotechnology has issued a report titled Down-hole Seismic Testing; WB-13 (see Appendix I). After the down-hole seismic testing was completed, Dr. Scott Olson ran site-specific analyses to propagate bedrock level shaking to the ground surface. His findings can be located in Appendix J, and the results are summarized in Table 4. The values presented in Table 4 will be used in the seismic design of the MSE wall.

**Table 4 – Final Site Specific Seismic Activity Data – Scott Olson**

$T_r$ Event Type	Magnitude	PGA at Rock (g)	PGA at Surface (g)	Site Amplification
2500 Yr Short Period	6.0	0.26	0.26-0.27	1.0
1000 Yr Short Period	5.6	0.13	0.19	1.5
2500 Yr Long Period	7.7	0.07	0.11-0.12	1.7
1000 Yr Long Period	7.5	0.07	0.10	1.4

NOTES:

"Short Period" events are assumed to represent the background source and are modeled by conditional mean spectra at 0.2 seconds.

"Long Period" events represent the NMSZ and are modeled by conditional mean spectra at 1.0 seconds.

**Liquefaction Analysis**

A liquefaction analysis was performed using a modified IDOT BBS Central Geotechnical Unit liquefaction worksheet. The Maximum Horizontal Ground Surface Acceleration value in the spreadsheet was set equivalent to the PGA for each year return period as

described in Table 4. The Design Earthquake Mean Magnitude and PGA parameters used were provided by Scott M. Olson, Ph.D., P.E.

The soil profiles for Borings WB-1 through WB-12 were analyzed for the surcharged (behind the wall) condition and non-surcharged (front of the wall) condition. The results indicated liquefiable layers in borings WB-01, WB-04, WB-06, WB-07, WB-08, WB-09, WB-10, WB-11, and WB-12 on the surcharged side of the wall and in borings WB-01, WB-02, WB-03, WB-04, WB-05 and WB-06 on the front side of the wall where no surcharge is experienced. See the summary spreadsheets included in Appendix G for information regarding the depths of the potential liquefaction. A summary chart is provided in Appendix G, graphically displaying the potentially liquefiable strata in front and behind the MSE wall at the wall boring locations. Liquefiable layers have been included in analyses for slope stability, lateral spreading and downdrag.

### **Global Stability Analysis**

The retaining wall cross-section has been analyzed using X-Stabl slope analysis program using both the Janbu and Block methods of analysis. Five areas, at approximate heights of 35 feet to 16 feet, have been selected for analysis. Under static loading, stability showed Factors of Safety to be in excess of the required values (see Table 2). For seismic loading the analyses were repeated with modifications reflecting:

- 2500 and 1000 year-short period events
- Additional driving force from ground acceleration
- Native soil properties , with reduced soil strength representing liquefied strata where potential liquefaction is indicated (see summary chart in Appendix G)

Using the maximum PGA values from Table 4 in such analyses is considered to be overly conservative. These PGA values can be reduced according to National Cooperative Highway Research Program (NCHRP) 611 (2008). Given a maximum height of 35 feet and using the mid spectral shape (See chart in Appendix K), a scaling factor of 75% may be used to reduce the PGA. Slope Stability analyses were run with the 75% PGA values. The results are found in Appendix H, Slope Stability X-Stabl Output and are summarized in Tables 5 and 6.

**Table 5 – Slope Stability for 2500 Yr-Short Period Event (75% PGA)**

Acceleration 0.19/0.20 2500 Yr, Short Period	Required Factor of Safety (FS)	Computed Factor of Safety of Wall at Station				
		439+50	440+23	441+23	443+70	447+50
Native Subgrade Janbu Analysis	1.0	0.934	0.840	0.975	1.348	1.233
Native Subgrade Block Analysis	1.0	0.833	0.770	0.924	1.236	1.364

**Table 6 – Slope Stability for 1000 Yr-Short Period Event (75% PGA)**

Acceleration 0.14 1000 Yr, Short Period	Required Factor of Safety (FS)	Computed Factor of Safety of Wall at Station				
		439+50	440+23	441+23	443+70	447+50
Native Subgrade Janbu Analysis	1.0*	1.041	1.041	1.115	1.627	1.556
Native Subgrade Block Analysis	1.0*	0.914	0.938	1.047	1.497	1.622

NOTE:

\* Following IDOT requirements for typical retaining walls under extreme (seismic) load case

The analyses indicate that some wall sections, which demonstrate satisfactory slope stability under static condition, possess inadequate Factor of Safety under seismic loading and in the presence of liquefaction. Stations around and less than 441+23 are vulnerable under the 2500-year event, and stations around and less than 440+23 are vulnerable in the 1000-year event. Evaluation of the X-Stabl results in Appendix H suggests that the failure planes driving these results are primarily associated with the soft, compressible clay and loose sand and loam stratum.

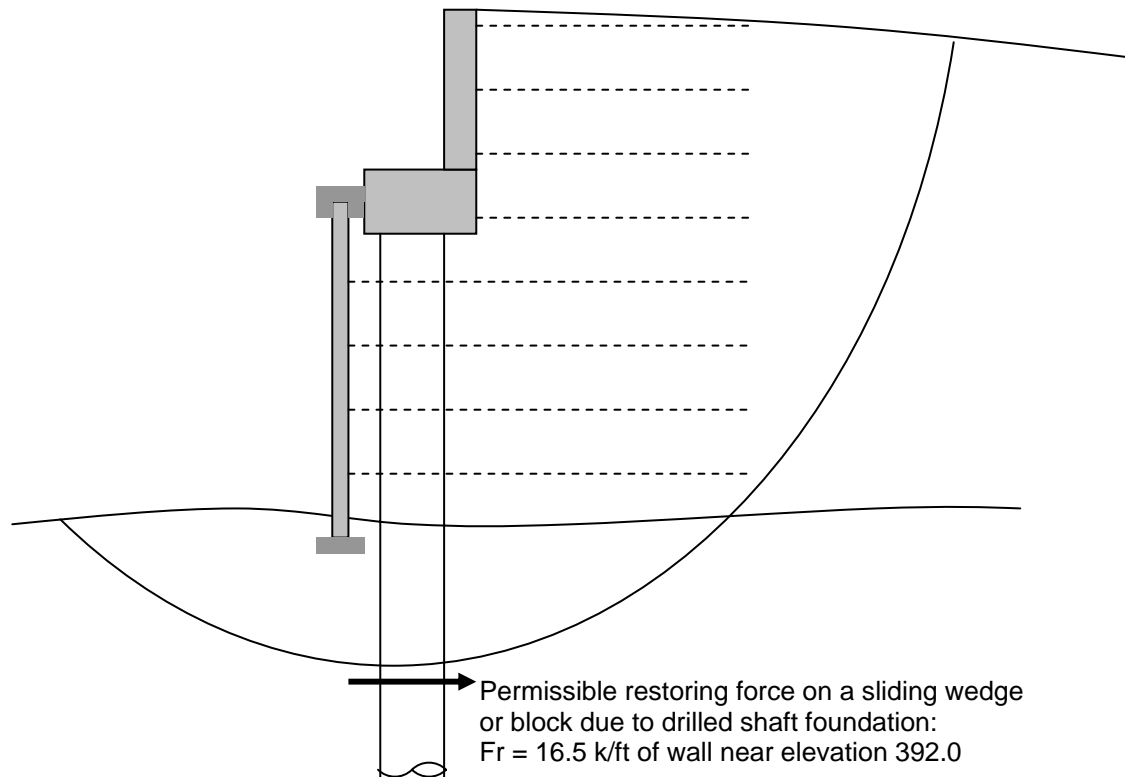
Failure to meet the required Factor of Safety is another indication that ground improvement is required in these areas. Preliminary exploratory analyses have shown that changes in soil properties associated with ground improvement are capable of improving the stability conditions to provide FS greater than 1.0 for the 1000-yr event.

At the 2500-year event, preliminary exploratory analyses have shown that some otherwise feasible and desirable ground improvement methods may yet be insufficient to provide FS greater than 1.0, specifically on sections cut through the bridge abutment, parallel to the centerline of I-70. This led to an evaluation of how much (if any) additional support could be assumed to be provided by the large diameter drilled shaft foundation supporting the abutment.

As designed, under the extreme event seismic load case, Teng has established that the drilled shafts can be assumed to provide a restoring force of 16.5 kips per foot of wall, acting on an assumed failure plane intersecting the foundations near an elevation of

392.0 (see Figure 3).

**Figure 3 – Diagram of Restoring Force thru Failure Wedge at the Abutment**



**Mononobe/Okabe Pseudo-Static Analysis**

Mononobe/Okabe analyses were calculated according to the AASHTO LRFD Bridge Design Specifications. In Table 7 is the summary of the factors of safety for sliding that were calculated. Factors of safety for the analyses performed were in excess of the required factor of safety of 1.0 for sliding during a seismic event.

**Table 7 – MSE Mononobe/Okabe Analyses Factors of Safety**

<b>Station</b>	<b>Factor of Safety: Mononobe/Okabe Block Sliding with Clay Fill (cohesion = 2000 psf)<sup>1</sup></b>	<b>Factor of Safety: Mononobe/Okabe Block Sliding with Granular Fill (phi = 28°)<sup>1</sup></b>
441+23	1.31	1.58
443+70	1.88	1.56
447+50	2.59	1.38

Notes:

1. Required FS=1.0

## **FOUNDATION (GROUND IMPROVEMENT) RECOMMENDATIONS**

### **MSE Foundation**

MSE wall foundations typically consist of preparatory grading and the construction of the leveling pad, upon which the first course of wall panels are set. According to drawings provided by Teng and Associates, preparatory grading will consist primarily of small amounts of filling, resulting in the leveling pad in this case will be constructed in newly placed embankment.

As noted in the *Analyses* section, there are deficiencies in strength, settlement and seismic stability in the existing soil conditions at and below the wall and reinforced soil zone areas. These deficiencies must be improved to attain satisfactory performance from the wall and ultimately the I-70 pavement.

Techniques available for such ground improvements may include (but are not limited) to:

- Removal and Replacement of Unsuitable Material
- Aggregate Columns
- Vibratory Compaction
- Soil Mixing
- Wick Drains
- Compaction Grouting

The Darling Spur MSE wall presents a case where the extents of a required improvement are both large and variable. Given the variability in conditions, requirements and available technologies, it may be advisable to approach ground improvement requirements in a Performance Specification Format. As opposed to specifying a particular method with associated quantities in the contract document, we recommend the Engineer provide performance requirements for the improved ground and the Contractor to design and submit for approval his most economical solution. The ground improvement would be quantified and bid as a lump sum item.



Under a Performance Specification Format, responsibility for confirming the evaluations and concerns identified in this report and for identifying any additional factors affecting the performance criteria should remain with the Contractor. For use of the Engineer in developing plans and specifications, and for the use of the Owner in evaluating contractor proposals, Table 8 is included, documenting our interpretation of the depths of unsuitable existing soils according to the boring logs. In plan extents, ground improvement should extend at least 5 feet outside the limits of the wall and the reinforced soil zone.

**Table 8 – Potential Limits of Contractor Designed Ground Improvements**

I-70 Station (Wall Station) (Boring & Grd. Elev.)	Approximate Bottom Elevation of Unsuitable Soil Stratum (ft) <sup>1</sup>	Q <sub>u</sub> Strength & Moisture Content (tsf, %)	Reason for Remedial Treatment
Sta 140+15 (440+04) to 141+48 (441+41) (WB-1, 406)	393	0.15, 43%	Low strength, High moisture content
Sta 141+48 (441+41) to 141+98 (441+92) (WB-2, 406)	395	0.3, 34%	Low strength, High moisture content
Sta 141+98 (441+92) to 142+48 (442+43) (WB-3, 406)	393	0.25, 35%	Low strength, High moisture content
Sta 142+48 (442+43) to 142+98 (442+95) (WB-4, 405)	392	0.5, 28%	Low strength, High moisture content
Sta 142+98 (442+95) to 143+50 (443+48) (WB-5, 406)	400	0.4, 31%	Low strength, High moisture content
Sta 143+50 (443+48) to 144+00 (444+00) (WB-6, 406)	398	0.3, 31%	Low strength, High moisture content
Sta 144+00 (444+00) to 144+50 (444+51) (WB-7, 406)	-	-	-
Sta 144+50 (444+51) to 145+00 (445+03) (WB-8, 405)	397	0.5, 27%	Low strength, High moisture content
Sta 145+00 (445+03) to 145+50 (445+54) (WB-9, 405)	392	0.2, 71%	Low strength, High moisture content
Sta 145+50 (445+54) to 146+12 (446+18) (WB-10, 405)	395	0.5, 33%	Low strength, High moisture content
Sta 146+12 (446+18) to 146+88 (446+96) (WB-11, 405)	402	1.3, 32%	Low strength, High moisture content
Sta 146+88 (446+96) to 147+35 (447+45) (WB-12, 413)	402	N/A (topsoil), 28%	Topsoil

NOTE: <sup>1</sup> Conditions should be verified in the field at time of construction

<sup>2</sup> Improvements should extend a minimum of 5' in front of the MSE wall and 5' behind the MSE wall straps

### **I-70 East Abutment MRB Connector Bridge Considerations**

The MSE wall will wrap around the I-70 Connector East Abutment. This connection is expected (per typical IDOT MSE/abutment design) to assist with stability in the area of the abutment. However, it is expected that the settlement caused by the MSE wall and adjacent embankment will cause down-drag forces on the drilled shafts. This has been addressed in the I-70 Curved Girder Bridge Structure geotechnical report. The settlement around the area of the east abutment and proposed straight-shaft caissons is required to be a maximum of 2.0 inches.

As shown in the liquefaction analysis in Appendix G, potentially liquefied strata extend deeper than what was previously discussed in the I-70 Curved Girder Bridge Report. According to the Kaskaskia liquefaction analyses in Appendix G, the 1000 year, seismic short-return period, potential liquefaction extends to elevation 390.0. For the 2500-yr. seismic short return period, potential liquefaction extends to elevation 350.0.

Although these liquefaction analyses in Appendix G indicate possible localized liquefaction to as deep as elevation 350, it is our opinion that deep localized liquefaction that would result in localized deep seated settlement and associated downdrag to these deeper elevations is unlikely due to confinement at these depths and we recommend that downdrag on the caissons be considered to Elev. 395, consistent with our I-70 Curved Girder SGR report dated October 1, 2009.

### **Adjacent Embankment to MSE Wall Considerations**

Settlement has been calculated by utilizing the consolidation data from the nearby borehole EB-04 at I-70 station 147+75, the consolidation data has been included in Appendix F of this report. Total settlement of embankment beyond the MSE wall is estimated to be on the order of 7 inches (for 20-foot fill) and 14 inches (for 35-foot fill). Based on data from nearby borehole EB-4, the estimated time for 90% consolidation of the soils is approximately 350 days. This assumes two-way drainage into the surface and underlying granular stratum. This settlement calculation is based on the existing soil conditions. Teng may choose to employ wick drains to accelerate settlements in the embankment beyond the MSE wall straps.

Paving should not be done until the settlement is nearly complete, because it is possible that the amount of settlement estimated for the embankment beyond/behind the MSE wall (7 to 14 inches of settlement estimated) may cause a crack to form between the end of the MSE wall strap location (less than 2 inches of settlement estimated). If such cracking does develop between the MSE wall and the adjacent embankment, a "fix" for the problem should be addressed prior to paving. The possibility for cracking should be addressed in the plans, and the MSE wall provider should be notified of the settlement extents.

### **Dewatering**

Basic dewatering techniques such as sump-pumps and hoses are not considered adequate to keep the site in the dry if the contractor design limits for ground improvements extend below an elevation 399. In addition to unfavorable conditions associated with wet construction, exposed saturated silty loams and sands can experience “quick conditions” without dewatering prior to undercutting to the saturated granular stratum. The contractor may use the option of deep dewatering wells along the wall alignment.

## **GENERAL CONSTRUCTION CONSIDERATIONS**

During excavation for the proposed improvements, movement of adjacent soils into the excavation should be prevented. All excavations should be performed in accordance with the latest Occupational Safety and Health Administration (OSHA) requirements. Allowances should be made for any surcharge loads adjacent to the retaining structures.

From the IDOT Standard Specifications for Roadway and Bridge Construction, excavation for structures should be in compliance with Section 502, and the construction of the MSE wall base pad should be in compliance with Section 503. MSE walls should be installed according to the specifications of the supplier approved by the engineer. Vertical and horizontal alignment should be in accordance with IDOT Specifications.

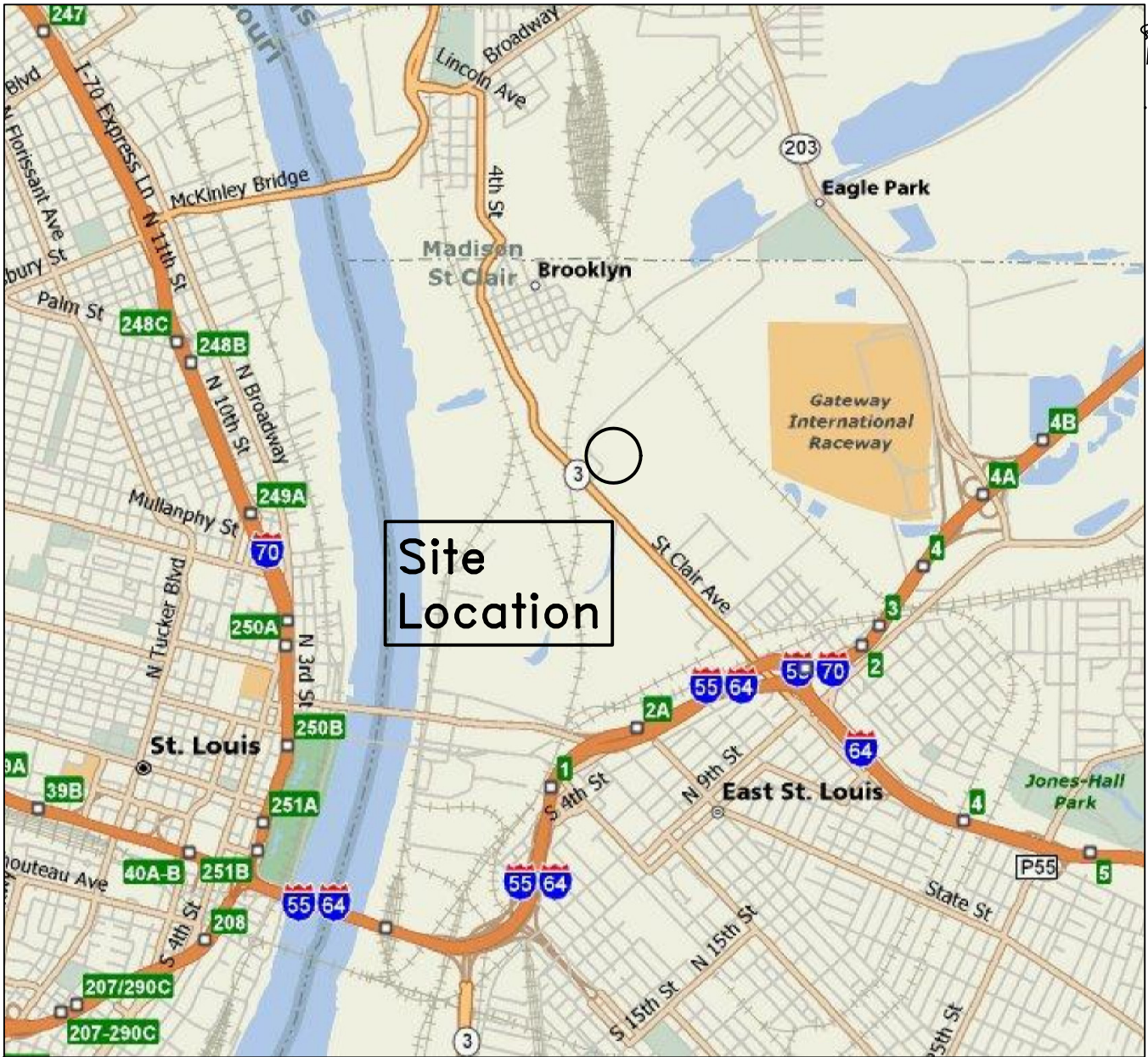
## **GENERAL QUALIFICATIONS**

The analysis and recommendations presented in this report are based upon the data obtained from our soil borings performed at the indicated locations. This report does not reflect any variations that may occur between borings or across the site. In addition, the soil samples cannot be relied on to accurately reflect the strata variations that usually exist between sampling locations. The nature and extent of such variations may not become evident until construction. If variations appear evident, it will be necessary to reevaluate the recommendations of the report. In addition, it is recommended that Geo Services Inc. be retained to perform construction observation and thereby provide a complete professional geotechnical engineering service through the observational method.

This report has been prepared for the exclusive use for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No other warranties, either expressed or implied,

are intended or made. In the event that any changes in the nature, design or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and the conclusions of this report modified or verified in writing by the geotechnical engineer. Also note that Geo Services Inc. is not responsible for any claims, damages, or liability associated with any other party's interpretation of this report's subsurface data or reuse of the report's subsurface data or engineering analyses without the express written authorization of Geo Services Inc.

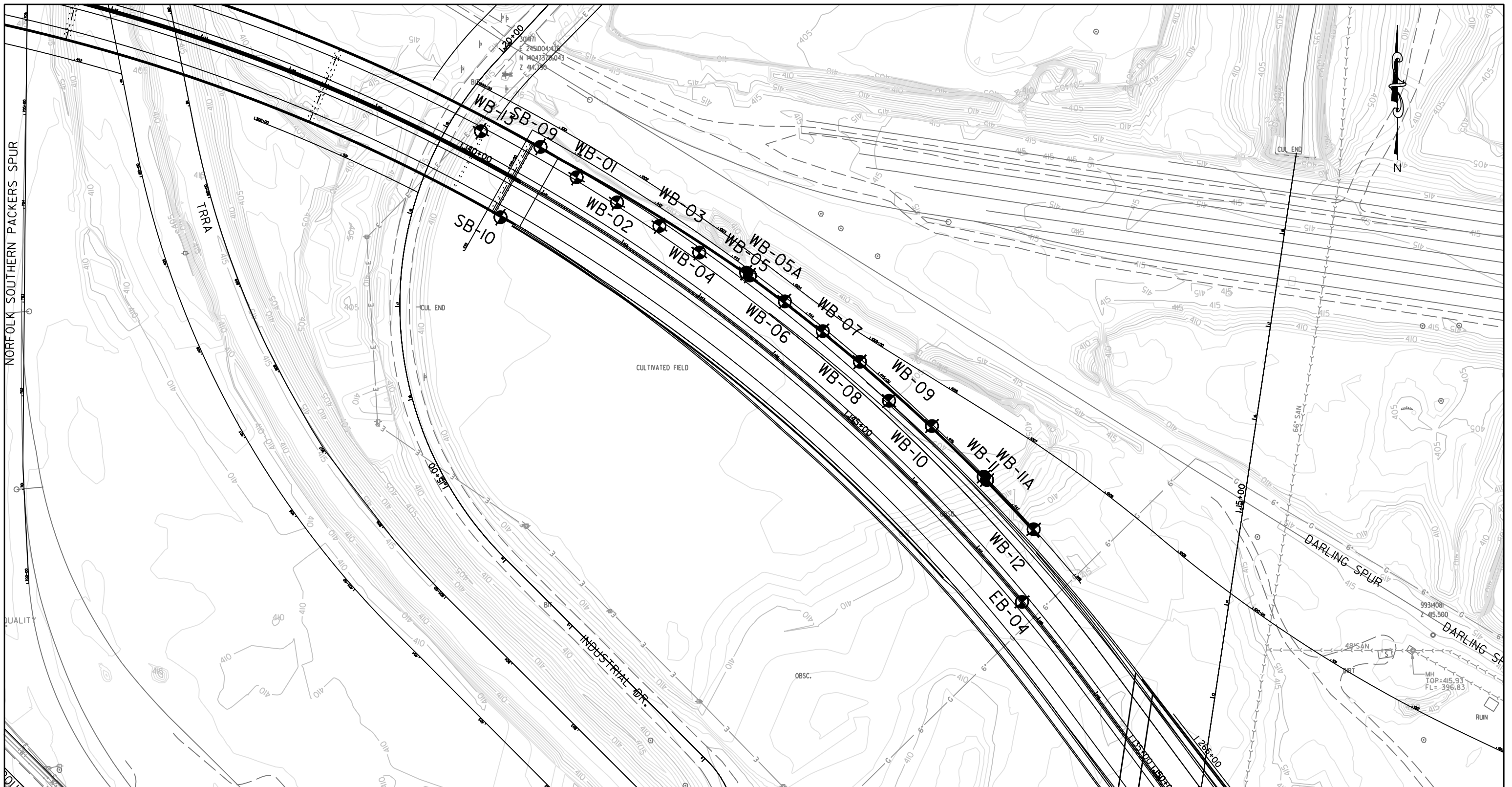
**APPENDIX A**  
**SITE LOCATION MAP**



Site  
Location

SITE LOCATION MAP	 <b>Geo Services, Inc.</b> Geotechnical, Environmental & Civil Engineering 805 Amherst Court, Suite 204 Naperville, Illinois 60565 (630) 355-2838	DRAWN BY	AUB
FAI Route 70, Special Bulletin 890 Darling Spur MSE Wall, Mississippi River IDOT Job: D-93-059-08 (Item160) St. Claire County, Illinois		APPROVED BY	AJP
		DATE	August 26, 2009
		GSI JOB No.	08201
		SCALE	NTS

**APPENDIX B**  
**BORING LOCATION DIAGRAM**



LEGEND

- WALL BORING ● WB-
- STRUCTURE BORING ● SB-
- EMBANKMENT BORING ● EB-

**Geo Services, Inc.**  
 Geotechnical, Environmental & Civil Engineering  
 805 Amherst Court, Suite 204  
 Naperville, Illinois 60565  
 (630) 355-2838

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED

FAI Route 70, Special Bulletin 890  
 Darling Spur MSE Wall, Mississippi River  
 IDOT Job No. D-93-059-08 (Item 160)  
 St. Claire County, Illinois

SOIL BORING LOCATION DIAGRAM

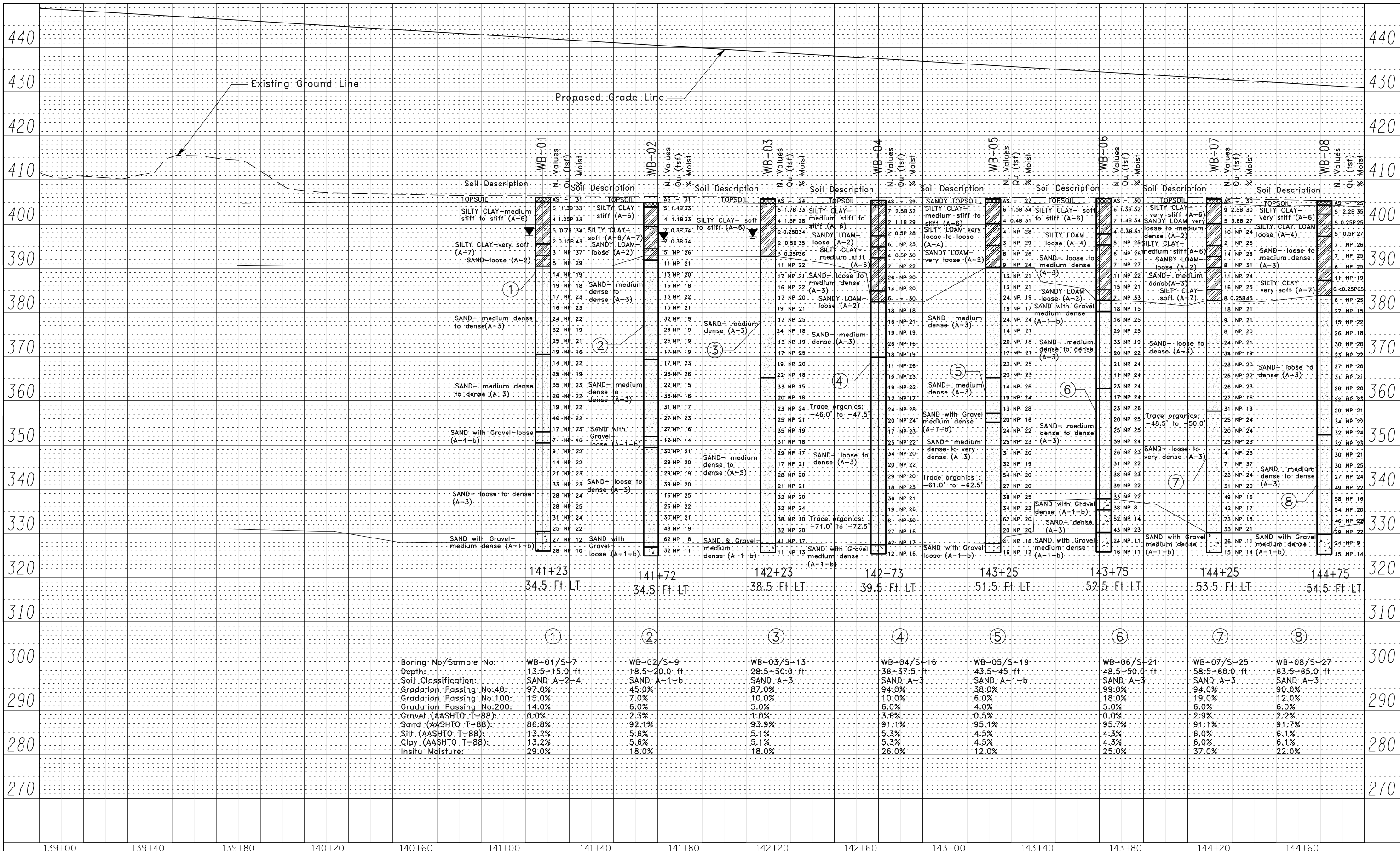
SIZE B	REV. 1	GSI Job No. 08201	DRAWN BY RWC	APPROVED BY AJP
SCALE: 1"=100'		DATE: 3-24-2010	SHEET: 1 OF 1	



**APPENDIX C**  
**SOIL PROFILES**

DATE	
BY	
PLAN	SURVEYED
	PLOTTED
	CHECKED
	AT
	NO.
	NO.
	NO.
	NO.

DATE	
BY	
PROFILE	SURVEYED
	GRADES
	CHECKED
	STRUCTURE
	NOTATIS
	CHRD
	NO.
	NO.
	NO.
	NO.



FILE NAME - P:\0033 TENG-PTB 090-160 I-70 NMRB IL Approach.CAD\CADD Sheets

USER NAME = cha  
 PLOT SCALE = 1:200  
 PLOT DATE = 3/23/2010

DESIGNED - TSR  
 DRAWN - TSR  
 CHECKED - MGM  
 DATE - 08/08/2009

REVISED 03/23/2010  
 REVISED -  
 REVISED -  
 REVISED -

STATE OF ILLINOIS  
 DEPARTMENT OF TRANSPORTATION

SCALE: 1"=200'  
 SHEET NO. 1 OF 2 SHEETS  
 STA. 139+00 TO STA. 145+00

F.A. RTE. 998  
 SECTION  
 COUNTY ST. CLAIR  
 TOTAL SHEETS 2  
 SHEET NO. 1  
 CONTRACT NO.  
 ILLINOIS FED. AID PROJECT



**APPENDIX D**  
**SOIL BORING LOGS**

# SOIL BORING LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structure-Retaining Wall

COUNTY St. Clair DRILLING METHOD Straight Flight Auger/Rotary HAMMER TYPE Diedrich Automatic

STRUCT. NO. 082-W234

Station: 140+70 to 147+35

BORING NO. **WB-01**

Station: 141+23 I-70, 441+40 Wall

Offset: 34.5' L I-70, 20.0' R Wall

Ground Surface Elev. 406.0

DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)	Surface Water Elev.	DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)
				Stream Bed Elev.				
				<u>n/a</u>				
				<u>n/a</u>				
				Groundwater Elevation:				
				First Encounter				
				Upon Completion				
				After 24 Hrs.				

TOPSOIL-black		AS	-	31				
	405.0							
		1		85		5		
		2				8		
		3	1.3B	33		9	NP	23
SILTY CLAY-brown-medium stiff to stiff (A-6) Wet		1				7		
		2				7		
		-5	2	1.25P	33	-25	9	NP 23
		1		82		10		
		2				11		
		3	0.7B	34		13	NP	22
		0		77		11		
		1				15		
		-10	1	0.15B	43	-30	17	NP 19
	395.5							
SILTY CLAY-brown-very soft (A-7) Wet		0				11		
		1				12		
		2	NP	37		13	NP	21
	393.0							
SAND-brown-loose (A-2-4)		0				6		
		2				10		
		-15	3	NP	29	-35	9	NP 16
	390.5							
SAND-brown-medium dense to dense (A-3)		5				6		
		7				7		
		7	NP	19		7	NP	22
		3				10		
		8				12		
		-20	11	NP	18	-40	13	NP 19

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS-Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery



# SOIL BORING LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structure-Retaining Wall

COUNTY St. Clair DRILLING METHOD Straight Flight Auger/Rotary HAMMER TYPE Diedrich Automatic

STRUCT. NO. 082-W234  
Station: 140+70 to 147+35

BORING NO. **WB-02**  
Station: 141+72 I-70, 441+66 Wall  
Offset: 34.5' L I-70, 20.5' R Wall  
Ground Surface Elev. 406.0

DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)	Surface Water Elev.	DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)
				Stream Bed Elev.				
				<u>n/a</u>				
				<u>n/a</u>				
				Groundwater Elevation:				
				First Encounter				
				Upon Completion				
				After 24 Hrs.				

DEPTH (ft)	BLOW (/6")	UCS (tsf)	MOIST (%)	Soil Description	DEPTH (ft)	BLOW (/6")	UCS (tsf)	MOIST (%)
405.0	AS	-	31	TOPSOIL-black	385.0			
	1		87			6		
	2					6		
	3	1.4B	33	SILTY CLAY-brown-stiff (A-6) Wet		7	NP	22
	1		84			3		
	2					7		
400.5	-5	2	1.1B	SAND-brown-medium dense to dense (A-3)	-25	8	NP	21
	1		86			8		
	1					11		
	1	0.3B	34	SILTY CLAY-brown-soft (A-6/A-7) Wet		21	NP	19
	1		88			10		
	1					12		
395.5	-10	1	0.3B		-30	14	NP	19
	1					10		
	1					13		
393.0	4	NP	26	SANDY LOAM-brown & gray-loose (A-2)		12	NP	19
	5					6		
	6					7		
	-15	5	NP	SAND-brown-medium dense (A-3)	-35	10	NP	19
	4					370.5		
	7					9		
388.0	6	NP	20			9		
	6					8	NP	23
	5					9		
	6					13		
	-20	10	NP	SAND with Gravel-brown-medium dense (A-1-b)	-40	13	NP	26

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS-Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery





# SOIL BORING LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structure-Retaining Wall

COUNTY St. Clair DRILLING METHOD Straight Flight Auger/Rotary HAMMER TYPE Diedrich Automatic

STRUCT. NO. 082-W234

Station: 140+70 to 147+35

BORING NO. **WB-03**

Station: 142+23 I-70, 442+18 Wall

Offset: 38.5' L I-70, 17.0' R Wall

Ground Surface Elev. 405.7

DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)	Surface Water Elev.	DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)
				Stream Bed Elev.				
				<u>n/a</u>				
				<u>n/a</u>				
				Groundwater Elevation:				
				First Encounter				
				Upon Completion				
				After 24 Hrs.				

TOPSOIL-black		AS	-	24					
	404.7								
		1		<b>88</b>		9			
		2				9			
		3	1.7B	33		8	NP	20	
		1				4			
		2				7			
SILTY CLAY-brown- soft to stiff (A-6) Wet		-5	2	1.5P	28	-25	12	NP	21
		0		<b>86</b>		8			
		1				8			
		1	0.25B	34		9	NP	25	
		0		<b>87</b>		6			
		1				13			
		-10	1	0.5B	35	-30	11	NP	18
		1				9			
		1				5			
		2	0.25P	36		8	NP	19	
	392.7								
		3				6			
		5				8			
		-15	6	NP	22	-35	9	NP	25
		5				6			
		7				9			
		10	NP	21		10	NP	20	
		8				7			
		8				9			
SAND-brown- medium dense (A-3)		-20	8	NP	22	-40	13	NP	18

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS-Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery









# SOIL BORING LOG

PAGE 1 of 2

DATE 7/23/2009

LOGGED BY MR

GSJ JOB No. 08201

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structure-Retaining Wall

COUNTY St. Clair DRILLING METHOD Straight Flight Auger/Rotary HAMMER TYPE Diedrich Automatic

STRUCT. NO. 082-W234

Station: 140+70 to 147+35

BORING NO. **WB-05**

Station: 143+25 I-70, 443+23 Wall

Offset: 51.5' L I-70, 4.5' R Wall

Ground Surface Elev. 405.7

DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)	Surface Water Elev.	DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)
				Stream Bed Elev.				
				<u>n/a</u>				
				<u>n/a</u>				
				Groundwater Elevation:				
				First Encounter				
				Upon Completion				
				After 24 Hrs.				

SANDY TOPSOIL-black		AS	-	27				
<i>404.8</i>								
		1		<b>88</b>		6		
		2				10		
		4	1.5B	34		14	NP	19
SILTY CLAY-brown-medium stiff to stiff (A-6) Wet								
		2		<b>89</b>		7		
		2				8		
		-5	2	0.4B	31	-25	11	NP 17
<i>400.2</i>								
		1				6		
		2				11		
SILTY LOAM-brown-very loose to loose (A-4) Wet		2	NP	28		13	NP	24
		1				7		
		1				7		
		-10	2	NP	29	-30	7	NP 21
<i>395.2</i>								
		3				4		
		5				10		
SANDY LOAM-brown-very loose (A-2)		3	NP	26		10	NP	18
		4				4		
		5				7		
		-15	4	NP	24	-35	10	NP 21
<i>390.2</i>								
		2				6		
		5				9		
SAND-brown-medium dense (A-3)		8	NP	21		14	NP	25
		3				NP		
		4				10		
		-20	9	NP	21	-40	13	NP 23

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS-Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery









# ROCK CORE LOG

PAGE 1 of 3

DATE 10/19-21/09

LOGGED BY DR

GSJ JOB No. 08201

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structures Retaining Wall

COUNTY St. Clair CORING METHOD Rotary Wash

STRUCT. NO. 082-W234 CORING BARREL TYPE & SIZE NX Double Swivel-5 ft

Station: 140+70 to 147+35 Core Diameter 2.0 in

BORING NO. **WB-05A** Top of Rock Elev. 299.6

Station: 143+30 I-70, 443+28 Wall Begin Core Elev. 299.6

Offset: 51.5' L I-70, 4.5' R Wall

Ground Surface Elev. 405.6

	DEPTH (ft)	CORE RUN (#)	RECOVERY (%)	R·Q·D (%)	CORE TIME (min /ft)	STRENGTH (tsf)
RUN 1 (-106.0' to -111.0') Mississippian System, Valmeyeran Series Limestone  Light gray to gray with horizontal bedding. Fine grained with numerous horizontal fractures throughout.	299.6 -111	1	100.0	46.6	n/a	1158● -108.9
RUN 2 (-111.0' to -116.0') Mississippian System, Valmeyeran Series Limestone  Light gray to gray with horizontal bedding. Fine grained with tight horizontal fractures throughout. Some chert nodules.	294.6 -116	2	100.0	86.8	n/a	1160● -114.3



# ROCK CORE LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structures Retaining Wall

COUNTY St. Clair CORING METHOD Rotary Wash

STRUCT. NO. 082-W234 CORING BARREL TYPE & SIZE NX Double Swivel-5 ft

Station: 140+70 to 147+35 Core Diameter 2.0 in

BORING NO. **WB-05A** Top of Rock Elev. 299.6

Station: 143+30 I-70, 443+28 Wall Begin Core Elev. 299.6

Offset: 51.5' L I-70, 4.5' R Wall

Ground Surface Elev. 405.6

DEPTH (ft)	CORE RUN (#)	RECOVERY (%)	R . Q . D . (%)	CORE TIME (min /ft)	STRENGTH (tsf)
---------------	--------------------	-----------------	--------------------	------------------------------	-------------------

RUN 3 (-116.0' to -121.0') 289.6  
 Mississippian System, Valmeyeran Series Limestone

Light gray to gray with horizontal bedding. Fine grained with tight horizontal fractures throughout. Some chert nodules.

289.6	3	98.0	81.0	n/a	778 <sup>⊙</sup> -117.1'
-------	---	------	------	-----	-----------------------------

RUN 4 (-121.0' to -126.0') 284.6  
 Mississippian System, Valmeyeran Series Limestone

Light gray to gray with horizontal bedding becoming darker gray @ -125.4'. Fine grained with tight horizontal fractures throughout. Some chert nodules.

284.6	4	98.0	86.0	n/a	1092 <sup>⊙</sup> -121.4'
-------	---	------	------	-----	------------------------------



# ROCK CORE LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structures Retaining Wall

COUNTY St. Clair CORING METHOD Rotary Wash

STRUCT. NO. 082-W234 CORING BARREL TYPE & SIZE NX Double Swivel-5 ft

Station: 140+70 to 147+35 Core Diameter 2.0 in

Top of Rock Elev. 299.6

BORING NO. **WB-05A** Begin Core Elev. 299.6

Station: 143+30 I-70, 443+28 Wall

Offset: 51.5' L I-70, 4.5' R Wall

Ground Surface Elev. 405.6

DEPTH (ft)	CORE RUN (#)	RECOVERY (%)	R·Q·D (%)	CORE TIME (min /ft)	STRENGTH (tsf)
---------------	--------------------	-----------------	--------------	------------------------------	-------------------

RUN 5 (-126.0' to -131.0') 279.6  
 Mississippian System, Valmeyeran Series Limestone

Gray with horizontal bedding. Slightly porous & fossiliferous with some chert replacement.  
 Horizontal fractures @ -126.5', -127.0', -127.8', -128.5 & -129.4'.

279.6	5	100.0	100.0	n/a	1219● -126.0
-131					
-136					



# SOIL BORING LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structure-Retaining Wall

COUNTY St. Clair DRILLING METHOD Straight Flight Auger/Rotary HAMMER TYPE Diedrich Automatic

STRUCT. NO. 082-W234  
 Station: 140+70 to 147+35

BORING NO. **WB-06**  
 Station: 143+75 I-70, 443+74 Wall  
 Offset: 52.5' L I-70, 4.0' R Wall  
 Ground Surface Elev. 405.8

DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)	Surface Water Elev.	DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)
				<u>n/a</u>				
				Groundwater Elevation:				
				First Encounter				
				Upon Completion				
				After 24 Hrs.				

TOPSOIL-black		AS	-	30	SAND-loose to medium dense (A-3)	385.3			
	404.8								
		2		<b>88</b>			4		
		2			SANDY LOAM-gray-loose (A-2)		3		
		4	1.3B	32			4	NP	33
						382.8			
SILTY CLAY-brown- soft to stiff (A-6) Wet		1		<b>86</b>	SAND with Gravel-brown- medium dense (A-1-b)		3		
		3					9		
		-5	4	1.4B			9	NP	15
						380.3			
		1		<b>92</b>			8		
		2					8		
	397.8	2	0.3B	31			8	NP	25
SILTY LOAM-brown-loose (A-4)		1					4		
		2					10		
		-10	3	NP	25		-30	19	NP
	395.3				SAND-brown- medium dense to dense (A-3)				
		2					9		
		2					16		
		4	NP	26			17	NP	19
		1					7		
SAND-brown- loose to medium dense (A-3)		2					9		
		-15	5	NP	27		-35	11	NP
		3					4		
		4					9		
		7	NP	22			12	NP	24
		5					4		
		6					5		
		-20	9	NP	21		-40	6	NP

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS=Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery



# SOIL BORING LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structure-Retaining Wall

COUNTY St. Clair DRILLING METHOD Straight Flight Auger/Rotary HAMMER TYPE Diedrich Automatic

STRUCT. NO. 082-W234

Station: 140+70 to 147+35

BORING NO. **WB-07**

Station: 144+25 I-70, 444+25 Wall

Offset: 53.5' L I-70, 3.0' R Wall

Ground Surface Elev. 405.7

D E P T H  (ft)	B L O W S  (/6")	U C S  Qu (tsf)	M O I S T  (%)	Surface Water Elev.	D E P T H  (ft)	B L O W S  (/6")	U C S  Qu (tsf)	M O I S T  (%)
				<u>n/a</u>				
				<u>n/a</u>				
				<u>n/a</u>				
				First Encounter				
				Upon Completion				
				After 24 Hrs.				

TOPSOIL-black		AS	-	30	SAND-brown-medium dense (A-3)	385.2				
404.7										
		2		87	SILTY CLAY-gray-soft (A-7) Wet		6		75	
		4					4			
		5	2.5B	30			4	0.25B	43	
SILTY CLAY-brown-very stiff (A-6) Wet						382.7				
		2		89			7			
		2					9			
		-5	3	3.6B	27		-25	9	NP	21
400.2										
		4					4			
		5					3			
SANDY LOAM-brown-very loose to medium dense (A-2)		5	NP	24			6	NP	21	
		1					4			
		1					5			
		-10	1	NP	25		-30	3	NP	20
395.2					SAND-brown-loose to dense (A-3)					
		1					8			
		6					9			
		8	2.0P	28			15	NP	21	
392.7										
		2					9			
		4					14			
		-15	4	NP	31		-35	20	NP	19
390.2										
		3					8			
		4					10			
SAND-brown-medium dense (A-3)		7	NP	24			13	NP	20	
		6					8			
		9					12			
		-20	7	NP	23		-40	13	NP	22

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS-Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery



# SOIL BORING LOG

PAGE 2 of 2

DATE 7/27/2009

LOGGED BY MR

GSJ JOB No. 08201

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structure-Retaining Wall

COUNTY St. Clair DRILLING METHOD Straight Flight Auger/Rotary HAMMER TYPE Diedrich Automatic

STRUCT. NO. 082-W234  
Station: 140+70 to 147+35

BORING NO. **WB-07**  
Station: 144+25 I-70, 444+25 Wall  
Offset: 53.5' L I-70, 3.0' R Wall  
Ground Surface Elev. 405.7

DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)	Surface Water Elev.	DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)
				Stream Bed Elev.				
				<u>n/a</u>				
				<u>n/a</u>				
				First Encounter				
				Upon Completion				
				After 24 Hrs.				

SAND-brown- loose to dense (A-3)										
		8								
		14								
		12	NP	23						
		6								
SAND-gray- loose to very dense (A-3)										
		13								
		-45	14	NP	16					
		15								
		14								
	17	NP	19							
				<i>357.7</i>						

Trace organics from -48.5' to -50.0'.										
		9								
		13								
		-50	12	NP	24					
		8								
SAND-gray- loose to very dense (A-3)										
		7								
		13	NP	24						
		10								
		10								
	-55	13	NP	23						
				<i>330.2</i>						
SAND with Gravel-brown & gray- medium dense (A-1-b)										
		5								
		3								
		1	NP	23						
		0								
Trace organics from -58.5' to -60.0'.										
		4								
		-60	3	NP	37					
				<i>325.7</i>						

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS=Vane Shear Test  
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
NR-No Recovery

# SOIL BORING LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structure-Retaining Wall

COUNTY St. Clair DRILLING METHOD Straight Flight Auger/Rotary HAMMER TYPE Diedrich Automatic

STRUCT. NO. 082-W234  
 Station: 140+70 to 147+35

BORING NO. **WB-08**  
 Station: 144+75 I-70, 444+77 Wall  
 Offset: 54.5' L I-70, 2.5' R Wall  
 Ground Surface Elev. 405.3

DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)	Surface Water Elev.	DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)
				<u>n/a</u>				
				Groundwater Elevation:				
				First Encounter				
				Upon Completion				
				After 24 Hrs.				

TOPSOIL-black		AS	-	25					
404.3									
		2		82	SILTY CLAY-gray-very soft (A-7) Wet				383.8
		2							7
SILTY CLAY-brown-very stiff (A-6) Wet		3	2.2B	35					4
402.3									2
									NP
		3							23
		2							7
SILTY CLAY LOAM-brown-loose (A-4) Wet		-5	3	0.25P	25				10
									-25
									17
		2							NP
		2							15
		3	0.5P	27					5
397.3					SAND-brown-loose to dense (A-3)				8
									7
									NP
		3							22
		3							5
		-10	4	NP	26				12
									-30
									14
									NP
SAND-brown-loose to medium dense (A-3)		3							18
		3							9
		4	NP	25					14
									16
									NP
		2							20
		3							9
		-15	3	NP	25				12
									-35
									11
									NP
		2							22
		3							10
		8	NP	19					12
387.3									15
									NP
									20
									9
SILTY CLAY-gray-very soft (A-7) Wet									15
		-20	3	0.25P	65				-40
									16
									NP
									21

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS=Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery





# SOIL BORING LOG

PAGE 2 of 2

DATE 7/27-28/2009

LOGGED BY MR

GSJ JOB No. 08201

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structure-Retaining Wall

COUNTY St. Clair DRILLING METHOD Straight Flight Auger/Rotary HAMMER TYPE Diedrich Automatic

STRUCT. NO. 082-W234

Station: 140+70 to 147+35

BORING NO. **WB-08**

Station: 144+75 I-70, 444+77 Wall

Offset: 54.5' L I-70, 2.5' R Wall

Ground Surface Elev. 405.3

DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)	Surface Water Elev.	DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)
				Stream Bed Elev.				
				<u>n/a</u>				
				<u>n/a</u>				
				First Encounter				
				Upon Completion				
				After 24 Hrs.				

SAND-brown-  
loose to dense (A-3)

SAND-gray-  
medium dense to dense (A-3)

SAND-gray-  
medium dense to dense (A-3)

SAND with Gravel-brown & gray-  
medium dense (A-1-b)

End Of Boring @ -80.0'  
Straight Flight Augers To -10.0'  
Rotary Drilling To Completion  
10.0' of 4.0"Ø Casing Used

*352.3*

*329.8*

*325.3*

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS=Vane Shear Test  
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
NR-No Recovery

# SOIL BORING LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structure-Retaining Wall

COUNTY St. Clair DRILLING METHOD Straight Flight Auger/Rotary HAMMER TYPE Diedrich Automatic

STRUCT. NO. 082-W234  
Station: 140+70 to 147+35

BORING NO. **WB-09**  
Station: 145+25 I-70, 445+28 Wall  
Offset: 44.5' L I-70, 13.0' R Wall  
Ground Surface Elev. 404.8

DEPTH (ft)	BLOW COUNT (/6")	UCS (tsf)	MOIST (%)	Surface Water Elev.	Stream Bed Elev.	Groundwater Elevation:	DEPTH (ft)	BLOW COUNT (/6")	UCS (tsf)	MOIST (%)
				<u>n/a</u>	<u>n/a</u>	First Encounter				
						Upon Completion				
						After 24 Hrs.				

TOPSOIL-black		AS	-	27						
	403.8									
		2		78	SILTY CLAY-gray-very soft (A-7) Wet			4		66
		2						2		
		3	1.1B	37				2	0.2B	51
						381.8				
		2		80				10		
SILTY CLAY-brown-medium stiff to stiff (A-6/A-7) Wet		3						12		
		-5	3	1.5B	36		-25	13	NP	16
		2		75				5		
		2	1.4S@					9		
		3	9.9%	44				11	NP	25
		3		83	SAND-brown & gray-medium dense to dense (A-3)			5		
		3						11		
		-10	3	0.9B	36		-30	16	NP	22
	394.3									
		0		56				9		
SILTY CLAY-gray-very soft (A-7) Wet		0						15		
		0	0.2B	71				23	NP	30
	391.8									
		5						10		
		1						17		
		-15	3	NP	21		-35	18	NP	19
SAND-brown-loose (A-3)		2						8		
		2						11		
		3	NP	26				16	NP	18
		1						7		
	385.3									
SILTY CLAY-gray-very soft (A-7) Wet		3						14		
		-20	5	NP	26		-40	12	NP	18

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS-Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery





# SOIL BORING LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structure-Retaining Wall

COUNTY St. Clair DRILLING METHOD Straight Flight Auger/Rotary HAMMER TYPE CME Automatic

STRUCT. NO. 082-W234

Station: 140+70 to 147+35

BORING NO. **WB-10**

Station: 145+75 I-70, 445+80 Wall

Offset: 56.5' L I-70, 1.5' R Wall

Ground Surface Elev. 404.7

D E P T H  (ft)	B L O W S  (/6")	U C S  Qu	M O I S T  (%)	Surface Water Elev.	D E P T H  (ft)	B L O W S  (/6")	U C S  Qu	M O I S T  (%)
				Stream Bed Elev.				
				<u>n/a</u>				
				<u>n/a</u>				
				First Encounter				
				Upon Completion				
				After 24 Hrs.				

	7					10		
	8					12		
	9	NP	21	SAND-brown & gray-medium dense to dense (A-3)		19	NP	23
	6					12		
	8					14		
-45	8	NP	16			28	NP	19
								339.2
	7					17		
	7			SAND & GRAVEL-brown & gray-loose (A-1-b)		5		
	11	NP	18			4	NP	17
								336.7
	7					12		
	11					19		
-50	16	NP	21			28	NP	22
				SAND-brown & gray-medium dense to dense (A-3)				
	10					11		
	17					9		
	24	NP	21			8	NP	16
								331.7
	13					28		
	18			SAND & GRAVEL-brown & gray-very dense (A-1)		50/5"		
-55	21	NP	19			75	NP	8
								329.2
	11					14		
	12			SAND-brown & gray-dense (A-3)		17		
	24	NP	21			30	NP	22
								326.7
	11					11		
	14			SAND & GRAVEL-brown & gray-loose to dense (A-1-b)		9		
-60	23	NP	20			8	NP	16

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS-Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery





# ROCK CORE LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structures Retaining Wall

COUNTY St. Clair CORING METHOD Rotary Wash

STRUCT. NO. 082-W234 CORING BARREL TYPE & SIZE NX Double Swivel-10 ft

Station: 140+70 to 147+35 Core Diameter 2.0 in

Top of Rock Elev. 298.7

BORING NO. **WB-10** Begin Core Elev. 298.7

Station: 145+75 I-70, 445+80 Wall

Offset: 56.5' L I-70, 1.5' R Wall

Ground Surface Elev. 404.7

DEPTH (ft)	CORE RUN (#)	RECOVERY (%)	R · Q · D · (%)	CORE TIME (min /ft)	STRENGTH (tsf)
---------------	--------------------	-----------------	--------------------	------------------------------	-------------------

RUN 1 (-106.0' to -116.0') 298.7

Mississippian System, Valmeyeran Series Limestone

Light gray & fine grained with horizontal bedding becoming. Some chert replacement throughout. Numerous horizontal fractures with some thin clay partings.

298.7	1	100.0	41.8	n/a	1177 <sup>●</sup> -106.3
-111.0					
-116.0					





# ROCK CORE LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structures Retaining Wall

COUNTY St. Clair CORING METHOD Rotary Wash

STRUCT. NO. 082-W234 CORING BARREL TYPE & SIZE NX Double Swivel-5 ft

Station: 140+70 to 147+35 Core Diameter 2.0 in

Top of Rock Elev. 298.7

BORING NO. **WB-10** Begin Core Elev. 298.7

Station: 145+75 I-70, 445+80 Wall

Offset: 56.5' L I-70, 1.5' R Wall

Ground Surface Elev. 404.7

DEPTH (ft)	CORE RUN (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min /ft)	STRENGTH (tsf)
---------------	--------------------	-----------------	---------------	------------------------------	-------------------

RUN 2 (-116.0' to -121.0') 288.7  
 Mississippian System, Valmeyeran Series Limestone

Light gray & fine grained with horizontal bedding becoming. Numerous horizontal fractures throughout. 1/4" clay partings @ -117.4', -117.6' & -118.2'.

288.7	2	100.0	59.5	n/a	1119 -118.8'
-121.0					
-126.0					



# SOIL BORING LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structure-Retaining Wall

COUNTY St. Clair DRILLING METHOD Straight Flight Auger/Rotary HAMMER TYPE Diedrich Automatic

STRUCT. NO. 082-W234

Station: 140+70 to 147+35

BORING NO. **WB-11**

Station: 146+50 I-70, 446+57 Wall

Offset: 58.0' L I-70, 1.0' R Wall

Ground Surface Elev. 405.4

DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)	Surface Water Elev.		DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)
				<u>n/a</u>	<u>n/a</u>				
				Stream Bed Elev.	<u>n/a</u>				
				Groundwater Elevation:					
				First Encounter	<u>n/a</u> ▼				
				Upon Completion	<u>n/a</u> ▼				
				After 24 Hrs.	<u>n/a</u> ▼				

		AS	-	38	SANDY CLAY LOAM-gray-loose (A-2)	384.9			
SILTY CLAY-brown-stiff (A-6) Wet	2			<b>83</b>			5		
	2						9		
	2	1.3B		32			11	NP	21
<i>402.4</i>									
	2						11		
	3						12		
	-5	3	NP	22			-25	11	NP 21
SILTY LOAM to LOAM-brown-loose (A-2/A-4)	2				SAND-brown & gray-medium dense to dense (A-3)				
	2						5		
	2						4		
	2	NP		25			7	NP	25
	2						4		
	2						6		
	-10	2	NP	27			-30	9	NP 25
<i>394.9</i>									
	3						8		
	4						9		
	4	NP		24			6	NP	24
SAND-brown-loose to medium dense (A-3)	1						6		
	3						10		
	-15	4	NP	27			-35	11	NP 16
	2						9		
	3						12		
	8	NP		19			16	NP	18
<i>387.4</i>									
	3						10		
SANDY CLAY LOAM-gray-loose (A-2)	2						10		
	-20	3	-	33			-40	12	NP 22

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS-Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery

# SOIL BORING LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structure-Retaining Wall

COUNTY St. Clair DRILLING METHOD Straight Flight Auger/Rotary HAMMER TYPE Diedrich Automatic

STRUCT. NO. 082-W234

Station: 140+70 to 147+35

BORING NO. **WB-11**

Station: 146+50 I-70, 446+57 Wall

Offset: 58.0' L I-70, 1.0' R Wall

Ground Surface Elev. 405.4

D E P T H  (ft)	B L O W S  (/6")	U C S  Qu	M O I S T  (%)	Surface Water Elev.	D E P T H  (ft)	B L O W S  (/6")	U C S  Qu	M O I S T  (%)
				Stream Bed Elev.				
				<u>n/a</u>				
				<u>n/a</u>				
				First Encounter				
				Upon Completion				
				After 24 Hrs.				

	8					12		
	13			SAND-brown & gray- medium dense to dense (A-3)		15		
	13	NP	21			21	NP	16
	7					8		
	11					12		
	-45	13	NP	21		-65	22	NP 17
								339.9
SAND-brown & gray- medium dense to dense (A-3)	8					11		
	13			SAND with Gravel-gray- medium dense (A-1-b)		14		
	11	NP	17			14	NP	10
	4					9		
	5					10		
	-50	6	NP	17		-70	15	NP 9
								334.9
	4			SAND-gray- medium dense to dense (A-1-b)		8		
	5					50		
	6	NP	16			33	NP	14
	5					10		
	7					16		
	-55	9	NP	16		-75	24	NP 18
	11					29		
	16					9		
	16	NP	22			12	NP	19
								327.4
	7			SAND with Gravel-medium dense (A-1-b)		8		
	11			End Of Boring @ -80.0'		6		
	-60	14	NP	20		-80	7	NP 13
				Straight Flight Augers To -10.0'				
				Rotary Drilling To Completion				325.4

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS-Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery



# SOIL BORING LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structure-Retaining Wall

COUNTY St. Clair DRILLING METHOD Hollow Stem Auger/Rotary HAMMER TYPE CME Automatic

STRUCT. NO. 082-W234  
Station: 140+70 to 147+35

BORING NO. **WB-11A**  
Station: 146+55 I-70, 446+62 Wall  
Offset: 58.0' L I-70, 1.0' R Wall  
Ground Surface Elev. 412.8

D E P T H  (ft)	B L O W S  (/6")	U C S  Qu	M O I S T  (%)	Surface Water Elev.	D E P T H  (ft)	B L O W S  (/6")	U C S  Qu	M O I S T  (%)
				<u>n/a</u>				
				<u>n/a</u>				
				<u>n/a</u>				
				Groundwater Elevation:				
				First Encounter				
				Upon Completion				
				After 24 Hrs.				

Light gray to gray with horizontal bedding. Fine grained with numerous horizontal fractures throughout.  RECOVERY=100.0% R.Q.D.=71.0%  <i>289.8</i>	RUN 2	Light gray to gray with horizontal to wavy bedding. Slightly porous with numerous horizontal fractures throughout. Thin clay partings @ -140.8', -141.4' & -142.5'.  RECOVERY=100.0% R.Q.D.=32.0%  <i>269.8</i>	RUN 6
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RUN 3 (-123.0' to -128.0') Mississippian System, Valmeyeran Series Limestone  Light gray to gray with horizontal to wavy bedding. Fine grained with numerous horizontal fractures throughout.  RECOVERY=100.0% R.Q.D.=32.5%  <i>284.8</i>	RUN 3	RUN 7 (-143.0' to -150.0') Mississippian System, Valmeyeran Series Limestone  Light gray to gray with horizontal to wavy bedding. Fine grained with horizontal fractures @ -143.9', -144.3', -144.7', -145.0', -145.3', -146.0', -146.6' & -147.4'. 1.0" clay parting @ -148.4'. Horizontal fractures @ -148.7', -149.1' & -149.9'.  RECOVERY=100.0% R.Q.D.=90.0%  <i>262.8-150</i>	RUN 7
--	-------	--	-------

RUN 4 (-128.0' to -133.0') Mississippian System, Valmeyeran Series Limestone  Light gray to gray with horizontal to wavy bedding becoming darker gray @ -131.9'. Fine grained with numerous horizontal fractures throughout.  RECOVERY=100.0% R.Q.D.=37.0%  <i>279.8</i>	RUN 4	End Of Boring @ -150.0' Hollow Stem Augers To -12.0' Rotary Drilling To Completion 17.0' of 5.0"Ø Casing Used 1115.0' of 3.0"Ø Casing Used CME Automatic Hammer	
---	-------	--	--

RUN 5 (-133.0' to -138.0') Mississippian System, Valmeyeran Series Limestone  Dark gray to gray with horizontal to wavy bedding becoming lighter gray @ -135.5'. Highly fractured with some chert nodules.  RECOVERY=100.0% R.Q.D.=13.5%  <i>274.8</i>	RUN 5		
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RUN 6 (-138.0' to -143.0') Mississippian System, Valmeyeran Series Limestone  <i>140</i>	RUN 6		
--	-------	--	--

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS-Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery

# ROCK CORE LOG

PAGE 1 of 4

DATE 10/19-21/09

LOGGED BY DR

GSJ JOB No. 08201

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structures Retaining Wall

COUNTY St. Clair CORING METHOD Rotary Wash

STRUCT. NO. 082-W234 CORING BARREL TYPE & SIZE NX Double Swivel-5 ft  
 Station: 140+70 to 147+35 Core Diameter 2.0 in

BORING NO. **WB-11A** Top of Rock Elev. 299.8  
 Station: 146+55 I-70, 446+62 Wall Begin Core Elev. 299.8

Offset: 58.0' L I-70, 1.0' R Wall  
 Ground Surface Elev. 412.8

	DEPTH (ft)	CORE RUN (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min /ft)	STRENGTH (tsf)
RUN 1 (-113.0' to -118.0') Mississippian System, Valmeyeran Series Limestone  Light gray to gray with horizontal bedding. Fine grained with numerous horizontal fractures throughout.	299.8	1	98.0	38.0	n/a	1190● -113.9'
	294.8 - 118.0					
RUN 2 (-118.0' to -123.0') Mississippian System, Valmeyeran Series Limestone  Light gray to gray with horizontal bedding. Fine grained with numerous horizontal fractures throughout.		2	100.0	71.0	n/a	1228● -120.6'
	-123.0					



Color pictures of the cores Yes \_\_\_\_\_ Cores will be stored for examination for \_\_\_\_\_  
 The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

# ROCK CORE LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structures Retaining Wall

COUNTY St. Clair CORING METHOD Rotary Wash

STRUCT. NO. 082-W234 CORING BARREL TYPE & SIZE NX Double Swivel-5 ft  
 Station: 140+70 to 147+35 Core Diameter 2.0 in

BORING NO. **WB-11A** Top of Rock Elev. 299.8  
 Station: 146+55 I-70, 446+62 Wall Begin Core Elev. 299.8

Offset: 58.0' L I-70, 1.0' R Wall  
 Ground Surface Elev. 412.8

	DEPTH (ft)	CORE RUN (#)	RECOVERY (%)	R·Q·D (%)	CORE TIME (min /ft)	STRENGTH (tsf)
RUN 3 (-123.0' to -128.0') Mississippian System, Valmeyeran Series Limestone  Light gray to gray with horizontal to wavy bedding. Fine grained with numerous horizontal fractures throughout.	289.8	3	100.0	32.5	n/a	1189● -127.6
	284.8 - 128.0					
RUN 4 (-128.0' to -133.0') Mississippian System, Valmeyeran Series Limestone  Light gray to gray with horizontal to wavy bedding becoming darker gray @ -131.9'. Fine grained with numerous horizontal fractures throughout.		4	100.0	37.0	n/a	1101● -128.1
	-133.0					



# ROCK CORE LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structures Retaining Wall

COUNTY St. Clair CORING METHOD Rotary Wash

STRUCT. NO. 082-W234 CORING BARREL TYPE & SIZE NX Double Swivel-5 ft  
 Station: 140+70 to 147+35 Core Diameter 2.0 in

BORING NO. **WB-11A** Top of Rock Elev. 299.8  
 Station: 146+55 I-70, 446+62 Wall Begin Core Elev. 299.8

Offset: 58.0' L I-70, 1.0' R Wall  
 Ground Surface Elev. 412.8

	DEPTH (ft)	CORE RUN (#)	RECOVERY (%)	R·Q·D (%)	CORE TIME (min /ft)	STRENGTH (tsf)
RUN 5 (-133.0' to -138.0') Mississippian System, Valmeyeran Series Limestone  Dark gray to gray with horizontal to wavy bedding becoming lighter gray @ -135.5'. Highly fractured with some chert nodules.	279.8	5	100.0	100.0	13.5	1024 <sup>⊙</sup> -133.0
	274.8					
	-138.0					
RUN 6 (-138.0' to -143.0') Mississippian System, Valmeyeran Series Limestone  Light gray to gray with horizontal to wavy bedding. Slightly porous with numerous horizontal fractures throughout. Thin clay partings @ -140.8', -141.4' & -142.5'.		6	100.0	32.0	n/a	623 <sup>⊙</sup> -140.0
	-143.0					





# ROCK CORE LOG

PAGE 4 of 4

DATE 10/19-21/09

LOGGED BY DR

GSJ JOB No. 08201

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structures Retaining Wall

COUNTY St. Clair CORING METHOD Rotary Wash

STRUCT. NO. 082-W234 CORING BARREL TYPE & SIZE NX Double Swivel-5 ft  
 Station: 140+70 to 147+35 Core Diameter 2.0 in

BORING NO. **WB-11A** Top of Rock Elev. 299.8  
 Station: 146+55 I-70, 446+62 Wall Begin Core Elev. 299.8

Offset: 58.0' L I-70, 1.0' R Wall  
 Ground Surface Elev. 412.8

DEPTH (ft)	CORE RUN (#)	RECO VERY (%)	R · Q · D · (%)	C O R E I M E (min /ft)	S T R E N G T H (tsf)
269.8	7	100.0	90.0	n/a	1053 -143.0
-148.0					
-153.0					

RUN 7 (-143.0' to -150.0')  
 Mississippian System, Valmeyeran Series Limestone

Light gray to gray with horizontal to wavy bedding. Fine grained with horizontal fractures @ -143.9', -144.3', -144.7', -145.0', -145.3', -146.0', -146.6' & -147.4'. 1.0" clay parting @ -148.4'. Horizontal fractures @ -148.7', -149.1' & -149.9'.



# SOIL BORING LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structure-Retaining Wall

COUNTY St. Clair DRILLING METHOD Straight Flight Auger/Rotary HAMMER TYPE CME Automatic

STRUCT. NO. 082-W234

Station: 140+70 to 147+35

BORING NO. **WB-12**

Station: 147+25 I-70, 447+34 Wall

Offset: 60.0' L I-70, 0.5' R Wall

Ground Surface Elev. 413.0

DEPTH (ft)	BLOW COUNT (/6")	UCS Qu (tsf)	MOIST (%)	Surface Water Elev.		DEPTH (ft)	BLOW COUNT (/6")	UCS Qu (tsf)	MOIST (%)
				<u>n/a</u>	<u>n/a</u>				
				Stream Bed Elev.	<u>n/a</u>				
				Groundwater Elevation:					
				First Encounter	<u>n/a</u> ▼				
				Upon Completion	<u>n/a</u> ▼				
				After 24 Hrs.	<u>n/a</u> ▼				
	AS	-	35	SILTY CLAY LOAM-very loose (A-4/A-6)		92.5			
	2						4		
	4						5		
	5	-	25				6	NP	23
				SAND-brown-medium dense (A-3)					
	2						3		
	1						5		
	-5	2	-	21		-25	6	NP	27
	1						5		
	1						5		
	0	-	31				6	NP	32
				405.0					
	2		82				4		66
	4						3		
	-10	4	1.9B	36		-30	2	0.4B	58
				402.0					
		ST	NP	17			2		
							2	<0.25P	57
	2						3		
	3						12		
	-15	3	NP	23		-35	9	NP	39
	1						0		61
	1						2		
	2	NP	33				1	0.4B	65
				395.0					
	3						2		
	1						2		
	-20	1	-	38		-40	3	NP	28

TOPSOIL with Cinders, Stone & Brick-very loose to loose (Fill)

SILTY CLAY-dark brown & gray-stiff (A-6/A-7) Wet

SILTY LOAM to LOAM-brown & gray-very loose (A-4)

SILTY CLAY LOAM-brown & gray-very loose (A-4/A-6)







# ROCK CORE LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structures Retaining Wall

COUNTY St. Clair CORING METHOD Rotary Wash

STRUCT. NO. 082-W234 CORING BARREL TYPE & SIZE NX Double Swivel-10 ft

Station: 140+70 to 147+35 Core Diameter 2.0 in

Top of Rock Elev. 300.0

BORING NO. **WB-12** Begin Core Elev. 299.5

Station: 147+25 I-70, 447+34 Wall

Offset: 60.0' L I-70, 0.5' R Wall

Ground Surface Elev. 413.0

DEPTH (ft)	CORE RUN (#)	RECOVERY (%)	R.Q.D. (%)	CORE RETI ME (min /ft)	STRENGTH (tsf)
---------------	--------------------	-----------------	---------------	------------------------------------	-------------------

RUN 1 (-113.5' to -123.5')	299.5	1	100.0	44.3	n/a	1010 -115.1'
Mississippian System, Valmeyeran Series Limestone						
Light gray & fine grained with horizontal bedding becoming. Some chert replacement throughout. Numerous horizontal fractures throughout.						
	-118.5					
	-123.5					



# ROCK CORE LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structures Retaining Wall

COUNTY St. Clair CORING METHOD Rotary Wash

STRUCT. NO. 082-W234 CORING BARREL TYPE & SIZE NX Double Swivel-5 ft

Station: 140+70 to 147+35 Core Diameter 2.0 in

BORING NO. **WB-12** Top of Rock Elev. 300.0

Station: 147+25 I-70, 447+34 Wall Begin Core Elev. 299.5

Offset: 60.0' L I-70, 0.5' R Wall

Ground Surface Elev. 413.0

	DEPTH (ft)	CORE RUN (#)	RECOVERY (%)	R.Q.D. (%)	CORE RETI ME (min /ft)	STRENGTH (tsf)
RUN 2 (-123.5' to -125.5') Mississippian System, Valmeyeran Series Limestone Light gray & fine grained with horizontal bedding becoming. Numerous horizontal fractures throughout.	289.5	2	84.0	16.5	n/a	n/a
RUN 3 (-125.5' to -130.5') Mississippian System, Valmeyeran Series Limestone Light gray & fine grained with horizontal bedding becoming. Numerous horizontal fractures throughout.	277.5	3	100.0	16.5	n/a	970● -128.5
	-128.5					
	-133.5					









# SOIL BORING LOG

PAGE 2 of 2  
 DATE 9/17-23/2009  
 LOGGED BY DR  
 GSI JOB No. 08201

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structure-Retaining Wall

COUNTY St. Clair DRILLING METHOD Hollow Stem Auger/Rotary HAMMER TYPE CME Automatic

STRUCT. NO. 082-W234  
 Station: 140+70 to 147+35

BORING NO. **WB-13**  
 Station: 140+11 I-70, 439+52 Wall  
 Offset: 27.5' L I-70, 29.0' R Wall  
 Ground Surface Elev. 406.9

DEPTH H S	B L O W S	U C S Qu	M O I S T T	Surface Water Elev.	D E P T H	B L O W S	U C S Qu	M O I S T T
				<u>n/a</u>				
				<u>n/a</u>				
				Groundwater Elevation:				
				First Encounter <u>n/a</u> ▼				
				Upon Completion <u>n/a</u> ▼				
				After 24 Hrs. <u>n/a</u> ▼				

Light gray to gray with horizontal bedding becoming lighter @ -120.6'. Fine grained with horizontal fractures @ -120.6', -121.3', -122.0', -122.3' & -122.5'. RECOVERY=100.0% R.Q.D.=94.0% <span style="float: right;">283.9</span>	-			-				-		
RUN 3 MISSISSIPPIAN SYSTEM, VALMEYERAN SERIES LIMESTONE Gray & slightly fossiliferous with horizontal bedding. Fine grained becoming slightly porous @ -125.4'. Horizontal fractures @ 123.6', -124.0', -124.5', -124.8', -125.4', -126.0', -126.4', -126.9' & -127.1'. RECOVERY=100.0% R.Q.D.=88.0% <span style="float: right;">278.9</span>	-			-				-		
RUN 4 MISSISSIPPIAN SYSTEM, VALMEYERAN SERIES LIMESTONE Light gray to gray with horizontal bedding. Fine grained with horizontal fractures @ -128.4', -129.1', -129.4', -130.1', -131.2', -131.4', -131.7' & -132.6'. RECOVERY=100.0% R.Q.D.=87.0% <span style="float: right;">273.9</span>	-			-				-		
RUN 5 MISSISSIPPIAN SYSTEM, VALMEYERAN SERIES LIMESTONE End Of Boring @ -133.0' Hollow Stem Augers To -12.0' Rotary Drilling To Completion 12.0' of 5.0"Ø Casing Used 108.0' of 3.0"Ø Casing Used CME Automatic Hammer	-			-				-		
	-			-				-		
	-			-				-		
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	-			-				-		

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS-Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery

# ROCK CORE LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structures Retaining Wall

COUNTY St. Clair CORING METHOD Rotary Wash

STRUCT. NO. 082-W234 CORING BARREL TYPE & SIZE NX Double Swivel-5 ft

Station: 140+70 to 147+35 Core Diameter 2.0 in

BORING NO. **WB-13** Top of Rock Elev. 298.9

Station: 140+11 I-70, 439+52 Wall Begin Core Elev. 298.9

Offset: 27.5' L I-70, 29.0' R Wall

Ground Surface Elev. 406.9

DEPTH (ft)	CORE RUN (#)	RECOVERY (%)	R . Q . D . (%)	CORE TIME (min /ft)	STRENGTH (tsf)
---------------	--------------------	-----------------	--------------------	------------------------------	-------------------

RUN 1 (-108.0' to -113.0')  
Mississippian System, Valmeyeran Series Limestone

Light gray to gray with horizontal bedding. Fine grained with numerous horizontal fractures throughout.

298.9

-113

298.9	1	100.0	31.0	n/a	1084 -111.0'
-------	---	-------	------	-----	-----------------

RUN 2 (-113.0' to -118.0')  
Mississippian System, Valmeyeran Series Limestone

Light gray to gray with horizontal bedding. Fine grained with numerous horizontal fractures throughout.

293.9

-118

293.9	2	94.0	58.6	n/a	1222 -113.4'
-------	---	------	------	-----	-----------------



# ROCK CORE LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structures Retaining Wall

COUNTY St. Clair CORING METHOD Rotary Wash

STRUCT. NO. 082-W234 CORING BARREL TYPE & SIZE NX Double Swivel-5 ft

Station: 140+70 to 147+35 Core Diameter 2.0 in

Top of Rock Elev. 298.9

BORING NO. **WB-13** Begin Core Elev. 298.9

Station: 140+11 I-70, 439+52 Wall

Offset: 27.5' L I-70, 29.0' R Wall

Ground Surface Elev. 406.9

	DEPTH (ft)	CORE RUN (#)	RECOVERY (%)	R . Q . D . (%)	CORE TIME (min /ft)	STRENGTH (tsf)
RUN 3 (-118.0' to -123.0') Mississippian System, Valmeyeran Series Limestone  Light gray to gray with horizontal bedding becoming lighter @ -120.6'. Fine grained with horizontal fractures @ -120.6', -121.3', -122.0', -122.3' & -122.5'.	288.9	3	100.0	94.0	n/a	1201● -118.5'
RUN 4 (-123.0' to -128.0') Mississippian System, Valmeyeran Series Limestone  Gray & slightly fossiliferous with horizontal bedding. Fine grained becoming slightly porous @ -125.4'. Horizontal fractures @ 123.6', -124.0', -124.5', -124.8', -125.4', -126.0', -126.4', -126.9' & -127.1'.	283.9	4	100.0	88.0	n/a	812● -123.0'



# ROCK CORE LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION 82-2-1HVB LOCATION I-70 Curved Approach Structures Retaining Wall

COUNTY St. Clair CORING METHOD Rotary Wash

STRUCT. NO. 082-W234 CORING BARREL TYPE & SIZE NX Double Swivel-5 ft

Station: 140+70 to 147+35 Core Diameter 2.0 in

Top of Rock Elev. 298.9

BORING NO. **WB-13** Begin Core Elev. 298.9

Station: 140+11 I-70, 439+52 Wall

Offset: 27.5' L I-70, 29.0' R Wall

Ground Surface Elev. 406.9

DEPTH (ft)	CORE RUN (#)	RECOVERY (%)	R.Q.D. (%)	CORE RETI ME (min /ft)	STRENGTH (tsf)
---------------	--------------------	-----------------	---------------	------------------------------------	-------------------

RUN 5 (-128.0' to -133.0') 278.9

Mississippian System, Valmeyeran Series Limestone

Light gray to gray with horizontal bedding. Fine grained with horizontal fractures @  
 -128.4', -129.1', -129.4', -130.1', -131.2', -131.4', -131.7' &  
 -132.6'.

278.9	5	100.0	87.0	n/a	787 <sup>⊙</sup> -128.0
-133					
-138					



# SOIL BORING LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION -- LOCATION I-70 Curved Approach Structures

COUNTY St. Clair DRILLING METHOD 3.25" Hollow Stem Auger HAMMER TYPE CME Automatic

STRUCT. NO. S.N. 082-0318  
 Station: 127+00 to 140+74

BORING NO. **SB-09**  
 Station: 140+74  
 Offset: 43.0' Left  
 Ground Surface Elev. 406.1

DEPTH H S	BLOW S	UCS Qu	MOIST T	Surface Water Elev.		DEPTH H S	BLOW S	UCS Qu	MOIST T
				(ft)	(/6")				
					<u>n/a</u>				
					<u>n/a</u>				

TOPSOIL-black  
 405.1 AS - 39

2  
 4  
 5 1.25P 40

SILTY CLAY-dark brown-  
 stiff to very stiff (A-7) Wet  
 2  
 -5 2 2.0P 30

84  
 ST 1.2B 33

2  
 2  
 -10 3 1.25P 31

393.1  
 3  
 4  
 4 1.25P 28

SANDY LOAM-brown-  
 very loose (A-2)  
 -15 1 NP 28

388.1  
 1  
 0  
 3 NP 28

SAND-brown & gray-  
 medium dense (A-3)  
 5  
 6  
 -20 10 NP 18

6  
 9  
 11 NP 19

SAND-brown & gray-  
 medium dense (A-3)  
 6  
 8  
 -25 9 NP 22

Clay seams from -26.0' to -27.5'.  
 3  
 7  
 10 NP 23

9  
 13  
 -30 16 NP 21

375.6  
 14  
 12  
 11 NP 17

SAND-gray-  
 medium dense to dense (A-3)  
 -35 11 NP 24

7  
 8  
 10 NP 18

10  
 16  
 -40 19 NP 23

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS=Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery



# SOIL BORING LOG

PAGE 2 of 4

DATE 3/16-17/2009

LOGGED BY DR

GSJ JOB No. 08201

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION -- LOCATION I-70 Curved Approach Structures

COUNTY St. Clair DRILLING METHOD 3.25" Hollow Stem Auger HAMMER TYPE CME Automatic

STRUCT. NO. S.N. 082-0318  
Station: 127+00 to 140+74

BORING NO. **SB-09**  
Station: 140+74  
Offset: 43.0' Left  
Ground Surface Elev. 406.1

DEPTH H S	BLOW W S	UCS Qu	MOIST T	Surface Water Elev.		DEPTH H S	BLOW W S	UCS Qu	MOIST T	
				(ft)	(/6")					(ft)
				<u>n/a</u>	<u>n/a</u>					
				<u>n/a</u>	<u>n/a</u>					
				Groundwater Elevation:						
				First Encounter	<u>n/a</u>					
				Upon Completion	<u>n/a</u>					
				After 24 Hrs.	<u>n/a</u>					

	12						8			
	15						12			
	13	NP	20				17	NP	25	
	8						8			
	6						8			
	-45	10	NP	22			-65	9	NP	24
	7						7			
	10						11			
	11	NP	24				18	NP	29	
	10						9			
	23						13			
	-50	31	NP	24			-70	22	NP	26
	9						10			
	9						17			
	11	NP	27				28	NP	24	
	5						13			
	6						9			
	-55	8	NP	15			-75	10	NP	14
	6									
	6						11			
	9	NP	20				8			
							6	NP	12	
	8						20			
	12						13			
	-60	14	NP	24			-80	10	NP	8

SAND-gray-medium dense to dense (A-3)

SAND-gray-medium dense to dense (A-3)

330.6

Gravel seams from -26.0' to -27.5'.

SAND & GRAVEL-brown & gray-medium dense (A-1)

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS=Vane Shear Test The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%) NR-No Recovery



# SOIL BORING LOG

PAGE 3 of 4

DATE 3/16-17/2009

LOGGED BY DR

GSJ JOB No. 08201

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION -- LOCATION I-70 Curved Approach Structures

COUNTY St. Clair DRILLING METHOD 3.25" Hollow Stem Auger HAMMER TYPE CME Automatic

STRUCT. NO. S.N. 082-0318  
Station: 127+00 to 140+74

BORING NO. **SB-09**  
Station: 140+74  
Offset: 43.0' Left  
Ground Surface Elev. 406.1

DEPTH (ft)	BLOW S (/6")	UCS (tsf)	MOIST (%)	Surface Water Elev. <u>n/a</u>	Stream Bed Elev. <u>n/a</u>	DEPTH (ft)	BLOW S (/6")	UCS (tsf)	MOIST (%)
				Groundwater Elevation:					
				First Encounter <u>n/a</u> ▼					
				Upon Completion <u>n/a</u> ▼					
				After 24 Hrs. <u>n/a</u> ▼					

SAND & GRAVEL medium dense (A-1)	325.6								
	12								
	11								
	10	NP	14						
SAND with Gravel-brown & gray-medium dense (A-1-b)									
	9								
	10								
	-85	9	NP	12					
	8								
	11								
	14	NP	9						
	8								
	10								
	-90	10	NP	13					
SAND-brown & gray-medium dense (A-3)									
	8								
	9								
	12	NP	12						
	12								
	17								
	-95	24	NP	18					
SAND & GRAVEL-brown & gray-very dense (A-1)									
	38								
	40								
	47	NP	4						
	31								
	25								
	-100	39	NP	9					

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS-Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery



# SOIL BORING LOG

PAGE 4 of 4

DATE 3/16-17/2009

LOGGED BY DR

GSJ JOB No. 08201

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION -- LOCATION I-70 Curved Approach Structures

COUNTY St. Clair DRILLING METHOD 3.25" Hollow Stem Auger HAMMER TYPE CME Automatic

STRUCT. NO. S.N. 082-0318

Station: 127+00 to 140+74

BORING NO. **SB-09**

Station: 140+74

Offset: 43.0' Left

Ground Surface Elev. 406.1

D E P T H  (ft)	B L O W S  (/6")	U C S  Qu (tsf)	M O I S T  (%)	Surface Water Elev.	<u>n/a</u>	D E P T H  (ft)	B L O W S  (/6")	U C S  Qu (tsf)	M O I S T  (%)
				Stream Bed Elev.	<u>n/a</u>				
				Groundwater Elevation:					
				First Encounter	<u>n/a</u> ▼				
				Upon Completion	<u>n/a</u> ▼				
				After 24 Hrs.	<u>n/a</u> ▼				

Gray & fine grained with horizontal bedding. No chert replacement encountered. Horizontal fractures @ -118.6', -121.0', -121.6', -122.2', -122.3' & -122.5'.  
Recovery=100.0%  
R.Q.D.=93.0% *283.1*

RUN 2

End Of Boring @ -123.0'  
Hollow Stem Augers To -12.5'  
Rotary Drilling To Completion  
CME Automatic Hammer  
10' Of 4"Ø Casing Used  
109' Of 3"Ø Casing Used

-125

-130

-135

-140

-145

-150

-155

-160

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS-Vane Shear Test  
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
NR-No Recovery



# ROCK CORE LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION -- LOCATION I-70 Curved Approach Structures

COUNTY St. Clair CORING METHOD Rotary Wash

STRUCT. NO. S.N. 082-0318 CORING BARREL TYPE & SIZE NX Double Swivel-10 ft

Station: 127+00 to 140+74 Core Diameter 2.0 in

BORING NO. **SB-09** Top of Rock Elev. 299.1

Station: 140+74 Begin Core Elev. 298.1

Offset: 43.0' Left

Ground Surface Elev. 406.1

DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE RETIME (min /ft)	STRENGTH (tsf)
298.1	1	100.0	58.0	n/a	883 -109.4
-113.0					
-118.0					

RUN 1 (-108.0' to -118.0')  
 Mississippian System, Valmeyeran Series Limestone

Light gray & fine grained with horizontal bedding becoming darker gray @ -115.6. Some chert replacement & numerous horizontal fractures throughout.



# ROCK CORE LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION -- LOCATION I-70 Curved Approach Structures

COUNTY St. Clair CORING METHOD Rotary Wash

STRUCT. NO. S.N. 082-0318 CORING BARREL TYPE & SIZE NX Double Swivel-5 ft

Station: 127+00 to 140+74 Core Diameter 2.0 in

BORING NO. **SB-09** Top of Rock Elev. 299.1

Station: 140+74 Begin Core Elev. 298.1

Offset: 43.0' Left

Ground Surface Elev. 406.1

DEPTH	CORE	RECOVERY	R.Q.D.	CORE TIME	STRENGTH
(ft)	(#)	(%)	(%)	(min/ft)	(tsf)

RUN 2 (-118.0' to -123.0') 288.1  
 Mississippian System, Valmeyeran Series Limestone

Gray & fine grained with horizontal bedding. No chert replacement encountered. Horizontal fractures @ -118.6', -121.0', -121.6', -122.2', -122.3' & -122.5'.

2 100.0 93.0 n/a 773<sup>⊙</sup>  
-118.0'

-123.0'

-128.0'



# SOIL BORING LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION -- LOCATION I-70 Curved Approach Structures

COUNTY St. Clair DRILLING METHOD 3.25" Hollow Stem Auger HAMMER TYPE CME Automatic

STRUCT. NO. S.N. 082-0318  
 Station: 127+00 to 140+74

BORING NO. **SB-10**  
 Station: 140+74  
 Offset: 43.0' Right  
 Ground Surface Elev. 406.7

DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)	Surface Water Elev.	DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)
				<u>n/a</u>				
				Groundwater Elevation:				
				First Encounter				
				Upon Completion				
				After 24 Hrs.				

TOPSOIL-black	405.7	AS	-	34				
		2		94		9		
		2				9		
		3	1.9B	28		10	NP	22
SILTY CLAY-dark brown-stiff (A-6/A-7) Wet		2		87		9		
		1				11		
	-5	2	1.3B	35	SAND-brown-loose to medium dense (A-3)	-25	11	NP 22
401.2								
SILTY CLAY LOAM-brown & gray-medium stiff (A-4/A-6) Wet		2				11		
		2				13		
		3	0.5P	28		14	NP	22
398.7								
SILTY LOAM to LOAM-brown & gray-loose (A-4)		3				10		
		3				8		
	-10	3	NP	26		-30	9	NP 21
396.2								
		2			Trace organics from -31.0' to -32.5'.	7		
		3				7		
		2	NP	24		12	NP	20
SAND-brown-loose to medium dense (A-3)		4				6		
		3				7		
	-15	4	NP	22		-35	11	NP 21
		5				9		
		6				9		
		7	NP	23		17	NP	24
		3				10		
		3				12		
	-20	5	NP	25		-40	14	NP 21

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS=Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery

# SOIL BORING LOG

PAGE 2 of 4

DATE 3/18-20/2009

LOGGED BY DR

GSJ JOB No. 08201

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION -- LOCATION I-70 Curved Approach Structures

COUNTY St. Clair DRILLING METHOD 3.25" Hollow Stem Auger HAMMER TYPE CME Automatic

STRUCT. NO. S.N. 082-0318  
 Station: 127+00 to 140+74

BORING NO. **SB-10**

Station: 140+74

Offset: 43.0' Right

Ground Surface Elev. 406.7

D E P T H  (ft)	B L O W S  (/6")	U C S  Qu	M O I S T  (%)	Surface Water Elev.		D E P T H  (ft)	B L O W S  (/6")	U C S  Qu	M O I S T  (%)
				<u>n/a</u>	<u>n/a</u>				
				Stream Bed Elev.	<u>n/a</u>				
				Groundwater Elevation:					
				First Encounter	<u>n/a</u> ▼				
				Upon Completion	<u>n/a</u> ▼				
				After 24 Hrs.	<u>n/a</u> ▼				

SAND-loose to medium dense (A-3)				366.2						
	8						12			
	13						14			
	13	NP	21				21	NP	23	
	9						10			
	19						12			
	-45	19	NP	18	SAND-gray- medium dense to very dense (A-3)		-65	12	NP	24
	11						7			
	23						13			
	28	NP	20		Trace organics from -66.0' to -67.5'.		14	NP	36	
	24						12			
	23						15			
	-50	36	NP	23			-70	17	NP	21
	23						12			
	30						20			
	33	NP	19				28	NP	15	
						333.7				
	10						10			
	10						9			
	-55	13	NP	24			-75	8	NP	12
	8						22			
	9						12			
	11	NP	23		SAND with Gravel-gray- medium dense to dense (A-1-b)		10		NR	
	8						15			
	9						17			
	-60	12	NP	23			-80	23	NP	13

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS-Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery

# SOIL BORING LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION -- LOCATION I-70 Curved Approach Structures

COUNTY St. Clair DRILLING METHOD 3.25" Hollow Stem Auger HAMMER TYPE CME Automatic

STRUCT. NO. S.N. 082-0318  
 Station: 127+00 to 140+74

BORING NO. **SB-10**  
 Station: 140+74

Offset: 43.0' Right  
 Ground Surface Elev. 406.7

DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)	Surface Water Elev.	DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)
				<u>n/a</u>				
				Groundwater Elevation:				
				First Encounter				
				Upon Completion				
				After 24 Hrs.				

SAND with Gravel-gray-medium dense to dense (A-1-b)										
		11								
		15			SAND with Gravel-gray-very dense (A-1-b)		36			
		12	NP	13			50/2"		NP	12
		13					45			
		15					302.2	39		
		-85	13	NP	11		-105	24	NP	10
		14			Drillers Observation: Cobbles & Boulders.		50/2"			
		11								
		9	NP	10						NR
										318.7

SAND-brown & gray-dense to very dense (A-3)										
		13			RUN 1 (-108.0' to -118.0')					
		15			Mississippian System, Valmeyeran Series Limestone					
		-90	21	NP	18		-110			
					Light gray & fine grained with horizontal bedding, & some chert replacement. Numerous horizontal fractures throughout.					
		24								
		38			Recovery=100.0% R.Q.D.=33.5%					
		50	NP	13						RUN1
		22								
		23								
	-95	29	NP	16		-115				
	18									
	32									
	50	NP	15							
										308.7

SAND with Gravel-gray-very dense (A-1-b)										
		50/5"			RUN 2 (-118.0' to -123.0')					
				Mississippian System, Valmeyeran Series Limestone						
										RUN 2
	-100		NP	16		-120				
										288.7

# SOIL BORING LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION -- LOCATION I-70 Curved Approach Structures

COUNTY St. Clair DRILLING METHOD 3.25" Hollow Stem Auger HAMMER TYPE CME Automatic

STRUCT. NO. S.N. 082-0318

Station: 127+00 to 140+74

BORING NO. **SB-10**

Station: 140+74

Offset: 43.0' Right

Ground Surface Elev. 406.7

DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)	Surface Water Elev.	DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)
				<u>n/a</u>				
				Groundwater Elevation:				
				First Encounter				
				Upon Completion				
				After 24 Hrs.				

Light gray & fine grained with horizontal bedding, & some chert replacement. Numerous horizontal fractures throughout, with some thin clay partings.  
  
 Recovery=100.0%  
 R.Q.D.=52.0%

RUN 2

*283.7*

End Of Boring @ -123.0'

Hollow Stem Augers To -10.0'

Rotary Drilling To Completion

CME Automatic Hammer

10' Of 4"Ø Casing Used

109' Of 3"Ø Casing Used

-125

-145

-130

-150

-135

-155

-140

-160

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS=Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery

# ROCK CORE LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION -- LOCATION I-70 Curved Approach Structures

COUNTY St. Clair CORING METHOD Rotary Wash

STRUCT. NO. S.N. 082-0318 CORING BARREL TYPE & SIZE NX Double Swivel-10 ft

Station: 127+00 to 140+74 Core Diameter 2.0 in

BORING NO. **SB-10** Top of Rock Elev. 298.7

Station: 140+74 Begin Core Elev. 298.7

Offset: 43.0' Right

Ground Surface Elev. 406.7

DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE RETI ME (min /ft)	STRENGTH (tsf)
---------------	-------------	-----------------	---------------	------------------------------------	-------------------

RUN 1 (-108.0' to -118.0') 298.7  
 Mississippian System, Valmeyeran Series Limestone

Light gray & fine grained with horizontal bedding, & some chert replacement. Numerous horizontal fractures throughout.

298.7	1	100.0	33.5	n/a	1161 -110.4
-113.0					
-118.0					



# ROCK CORE LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION -- LOCATION I-70 Curved Approach Structures

COUNTY St. Clair CORING METHOD Rotary Wash

STRUCT. NO. S.N. 082-0318 CORING BARREL TYPE & SIZE NX Double Swivel-5 ft

Station: 127+00 to 140+74 Core Diameter 2.0 in

BORING NO. **SB-10** Top of Rock Elev. 298.7

Station: 140+74 Begin Core Elev. 298.7

Offset: 43.0' Right

Ground Surface Elev. 406.7

DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE RETI ME (min /ft)	STRENGTH (tsf)
---------------	-------------	-----------------	---------------	------------------------------------	-------------------

RUN 2 (-118.0' to -123.0') 288.7  
 Mississippian System, Valmeyeran Series Limestone

Light gray & fine grained with horizontal bedding, & some chert replacement. Numerous horizontal fractures throughout, with some thin clay partings.

2	100.0	52.0	n/a	1012	-119.3'
---	-------	------	-----	------	---------

-123.0

-128.0





## **APPENDIX E**

### **ROCK CORE COMPRESSIVE STRENGTH RESULTS**



## **APPENDIX F**

**BD-508A, LAB DATA & BORING LOG EB-04 & EB-05**

Route I-70 Tri-Level Connection  
 Section 82-2-HVB  
 County St. Clair  
 Location Darling Spur MSE Wall

Boring No./Sample No.	WB-01 / S-3	WB-01 / S-5	WB-01/S-7	WB-02/S-9
Station	141+23	141+23	141+23	141+72
Offset	34.5' L	34.5' L	34.5' L	34.5' L
Depth	3.5-5.0 ft	8.5-10.0 ft	13.5-15.0 ft	18.5-20.0 ft
AASHTO Classification	A-7	A-7	A-2-4	A-1-b
Illinois Textural Classification	SILTY CLAY	SILTY CLAY	Sand	Sand
Gradation Passing – 1"	100 %	100 %	100 %	100 %
¾"	100 %	100 %	100 %	100 %
½"	100 %	100 %	100 %	100 %
No. 4	100 %	100 %	100 %	100 %
No. 10	100 %	100 %	100 %	98 %
No. 40	100 %	100 %	97 %	45 %
No. 100	100 %	100 %	15 %	7 %
No. 200	98 %	97 %	14 %	6 %
Gravel (AASHTO T-88)	0.0 %	0.0 %	0.0 %	2.3 %
Sand (AASHTO T-88)	1.8 %	2.6 %	86.8 %	92.1 %
Silt (AASHTO T-88)	50.4 %	54.0 %	13.2 %	5.6 %
Clay (AASHTO T-88)	47.8 %	43.5 %	13.2 %	5.6 %
Liquid Limit (AASHTO T-89)	64	50	-	-
Plasticity Index (AASHTO T-90)	45	34	-	-
Std. Dry Density pcf (AASHTO T-99)	--	--	-	-
Optimum Moisture (AASHTO T-99)	--	--	-	-
Subgrade Support Rating	--	--	-	-
Organic Content	--	--	-	-
Insitu Moisture	33.0 %	43.0 %	29 %	18 %

Route I-70 Tri-Level Connection  
 Section 82-2-HVB  
 County St. Clair  
 Location Darling Spur MSE Wall

Boring No./Sample No.	WB-03/S-13	WB-04 / S-3	WB-04 / S-6	WB-04/S-16
Station	142+23	142+73	142+73	142+73
Offset	38.5' L	39.5' L	39.5' L	39.5'
Depth	28.5-30.0 ft	3.5-5.0 ft	11.0-12.5 ft	36.0-37.5 ft
AASHTO Classification	A-3	A-7	A-6	A-3
Illinois Textural Classification	Sand	SILTY CLAY	LOAM	Sand
Gradation Passing – 1"	100 %	100 %	100 %	100 %
¾"	100 %	100 %	100 %	100 %
½"	100 %	100 %	100 %	100 %
No. 4	100 %	100 %	100 %	99 %
No. 10	99 %	100 %	100 %	96 %
No. 40	87 %	100 %	100 %	94 %
No. 100	10 %	99.5 %	87.0 %	10 %
No. 200	5 %	98.0 %	68.0 %	6 %
Gravel (AASHTO T-88)	1.0 %	0.0 %	0.0 %	3.6 %
Sand (AASHTO T-88)	93.9 %	2.2 %	32.4 %	91.1 %
Silt (AASHTO T-88)	5.1 %	60.3 %	49.8 %	5.3 %
Clay (AASHTO T-88)	5.1 %	37.5 %	17.8 %	5.3 %
Liquid Limit (AASHTO T-89)	-	50	31	-
Plasticity Index (AASHTO T-90)	-	32	16	-
Std. Dry Density pcf (AASHTO T-99)	-	--	--	-
Optimum Moisture (AASHTO T-99)	-	--	--	-
Subgrade Support Rating	-	--	--	-
Organic Content	-	--	--	-
Insitu Moisture	18 %	29.0 %	30.0 %	26 %

Route I-70 Tri-Level Connection  
 Section 82-2-HVB  
 County St. Clair  
 Location Darling Spur MSE Wall

Boring No./Sample No.	WB-05/S-19	WB-06/S-21	WB-07/S-25	WB-08/S-27
Station	143+25	143+75	144+25	144+75
Offset	51.5' L	52.5' L	53.5' L	54.5' L
Depth	43.5-45.0 ft	48.5-50.0 ft	58.5-60.0 ft	63.5-65.0 ft
AASHTO Classification	A-1-b	A-3	A-3	A-3
Illinois Textural Classification	Sand	Sand	Sand	Sand
Gradation Passing – 1"	100 %	100 %	100 %	100 %
¾"	100 %	100 %	100 %	100 %
½"	100 %	100 %	100 %	100 %
No. 4	100 %	100 %	99 %	99 %
No. 10	100 %	100 %	97 %	98 %
No. 40	38 %	99 %	94 %	90 %
No. 100	6 %	18 %	19 %	12 %
No. 200	4 %	5 %	6 %	6 %
Gravel (AASHTO T-88)	0.5 %	0.0 %	2.9 %	2.2 %
Sand (AASHTO T-88)	95.1 %	95.7 %	91.1 %	91.7 %
Silt (AASHTO T-88)	4.5 %	4.3 %	6.0 %	6.1 %
Clay (AASHTO T-88)	4.5 %	4.3 %	6.0 %	6.1 %
Liquid Limit (AASHTO T-89)	-	-	-	-
Plasticity Index (AASHTO T-90)	-	-	-	-
Std. Dry Density pcf (AASHTO T-99)	-	-	-	-
Optimum Moisture (AASHTO T-99)	-	-	-	-
Subgrade Support Rating	-	-	-	-
Organic Content	-	-	-	-
Insitu Moisture	24 %	25 %	37 %	22 %

Route I-70 Tri-Level Connection  
 Section 82-2-HVB  
 County St. Clair  
 Location Darling Spur MSE Wall

Boring No./Sample No.	WB-09/S-30	WB-11 / S-2	WB-11 / S-4	WB-11/S-33
Station	145+25	146+50	146+50	146+50
Offset	44.5' L	58.0' L	58.0' L	58.0' L
Depth	71.0-72.5 ft	1.0-2.5 ft	6.0-7.5 ft	78.5-80.0 ft
AASHTO Classification	A-1-b	A-7	A-4	A-1-b
Illinois Textural Classification	Sand	CLAY	SANDY LOAM	Sand with Gravel
Gradation Passing – 1"	100 %	100 %	100 %	100 %
¾"	100 %	100 %	100 %	100 %
½"	100 %	100 %	100 %	95 %
No. 4	96 %	100 %	100 %	84 %
No. 10	86 %	100 %	100 %	76 %
No. 40	35 %	99 %	100 %	34 %
No. 100	9 %	98 %	67.5 %	10 %
No. 200	4 %	97 %	49.0 %	6 %
Gravel (AASHTO T-88)	13.6 %	0.0 %	0.0 %	24.1 %
Sand (AASHTO T-88)	82.0 %	3.0 %	50.8 %	70.2 %
Silt (AASHTO T-88)	4.4 %	49.6 %	36.4 %	5.7 %
Clay (AASHTO T-88)	4.4 %	47.4 %	12.8 %	5.7 %
Liquid Limit (AASHTO T-89)	-	61	24	-
Plasticity Index (AASHTO T-90)	-	41	6	-
Std. Dry Density pcf (AASHTO T-99)	-	--	--	-
Optimum Moisture (AASHTO T-99)	-	--	--	-
Subgrade Support Rating	-	--	--	-
Organic Content	-	--	--	-
Insitu Moisture	11 %	32.0 %	25.0 %	13 %

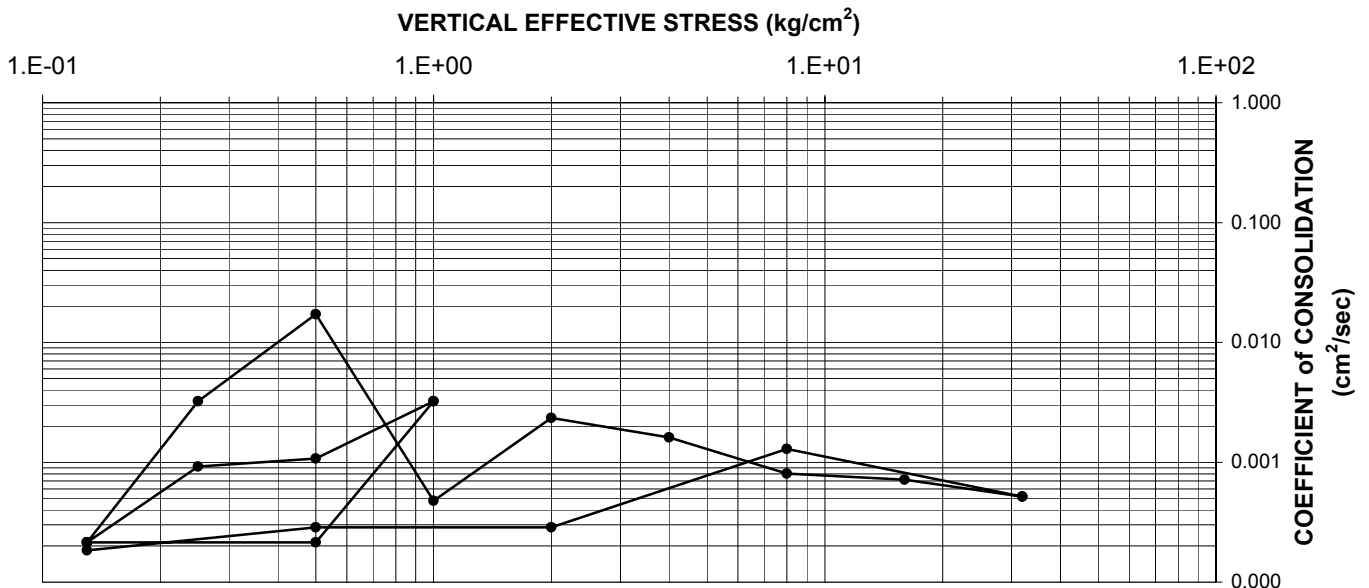
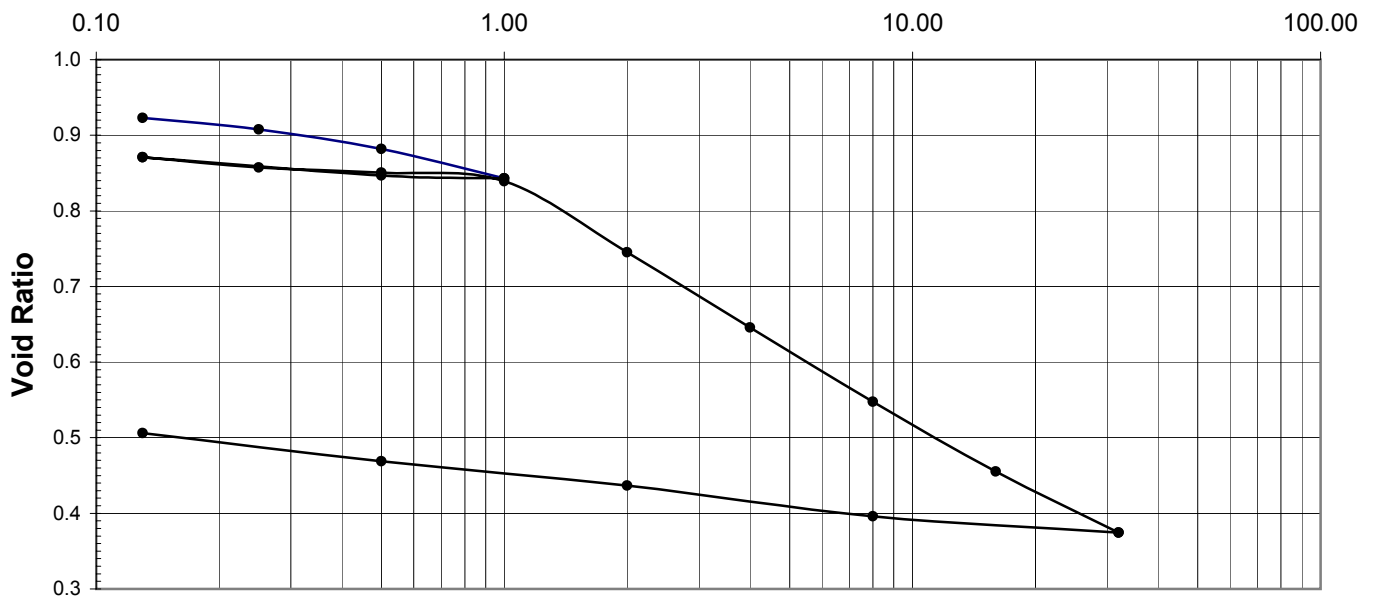
Route I-70 Tri-Level Connection  
 Section 82-2-HVB  
 County St. Clair  
 Location Darling Spur MSE Wall

Boring No./Sample No.	SB-09/S-4	SB-10/S-13		
Station	140+74	140+74		
Offset	43.0' Left	43.0' Right		
Depth	6.0-8.0 ft	28.5-30.0 ft		
AASHTO Classification	A-7	A-3		
Illinois Textural Classification	Silty Clay	Sand		
Gradation Passing – 1"	100 %	100 %		
¾"	100 %	100 %		
½"	100 %	100 %		
No. 4	100 %	100 %		
No. 10	100 %	98.1 %		
No. 40	100 %	64.8 %		
No. 100	100 %	8.8 %		
No. 200	99.6 %	3.8 %		
Gravel (AASHTO T-88)	0.0 %	1.9 %		
Sand (AASHTO T-88)	0.4 %	94.3 %		
Silt (AASHTO T-88)	62.4 %	3.8 %		
Clay (AASHTO T-88)	37.2 %	--		
Liquid Limit (AASHTO T-89)	48	--		
Plasticity Index (AASHTO T-90)	30	--		
Std. Dry Density pcf (AASHTO T-99)	--	--		
Optimum Moisture (AASHTO T-99)	--	--		
Subgrade Support Rating	--	--		
Organic Content	-	--		
Insitu Moisture	33.0 %	21.0 %		



Project Name	I-70 Tri-Level Connection, IDOT Job No. D-98-059-08			Job No	08201
Location	St. Clair County, Illinois			Test Date	3/27/09 to 4/20/09
Boring No	EB-04	Sample No	6	Depth	11.0' to 13.0'
Sample Description	SILTY CLAY LOAM (A-7)-brown & gray			Pc=	0.8 ksc
Station	147+75	Offset	Baseline	Cc=	0.315
				Ccr=	0.061

### Consolidation Test (32 tsf)-ASTM D2435 Summary Report



# SOIL BORING LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION XX LOCATION I-70 Embankment

COUNTY St. Clair DRILLING METHOD 3.25" Hollow Stem Auger HAMMER TYPE CME Automatic

STRUCT. NO. n/a

Station: n/a

BORING NO. **EB-04**

Station: 147+75

Offset: Baseline

Ground Surface Elev. 412.5

DEPTH (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)	Surface Water Elev.	DEPTH (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)
				<u>n/a</u>				
				<u>n/a</u>				
				<u>n/a</u>				
				Groundwater Elevation:				
				First Encounter	<u>n/a</u>	▼		
				Upon Completion	<u>n/a</u>	▼		
				After 24 Hrs.	<u>n/a</u>	▼		

5.0" CONCRETE, 7.0" SANDY LOAM	411.5	AS	-	18	SANDY LOAM-loose (A-2)	392.0			
--------------------------------	-------	----	---	----	------------------------	-------	--	--	--

		5						5	
SILTY CLAY-dark brown to black-medium stiff (A-6)		9						4	
		7	0.7B	20				5	NP 27
	409.5								

		2						7	
		2						4	
		-5	3	1.0P	36	SANDY LOAM-gray-loose to medium dense (A-2)		-25	5 NP 21

SILTY CLAY LOAM-dark brown & gray-stiff (A-7) Wet		2						6	
		3						7	
		4	1.5P	40				9	NP 27

		2						4	
		5						2	
		-10	5	1.4B	35			-30	6 NP 27

		2						4	
		5						2	
		-10	5	1.4B	35			-30	6 NP 27

		2						4	
		5						2	
		-10	5	1.4B	35			-30	6 NP 27
								12	
								10	
								9	NP 22
	399.5		ST	1.25P	35			379.5	

		1						11	
		1						10	
		-15	1	0.25P	33	SAND-gray-medium dense (A-3)		-35	10 NP 23

SILTY LOAM-trace organics-brown & gray-very loose (A-4)		2						7	
		1						9	
		1	0.25P	33				13	NP 22

		1						11	
		1						10	
		-15	1	0.25P	33	SAND-gray-medium dense (A-3)		-35	10 NP 23
		2						7	
		1						9	
		1	0.25P	33				13	NP 22
	394.5							374.5	

SANDY LOAM-trace organics-dark brown & gray-loose (A-2)		3						1	
		3						2	
		-20	2	NP	35	SILTY CLAY-dark gray-medium stiff (A-7) Wet		-40	6 0.7B 53

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS=Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery

# SOIL BORING LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION XX LOCATION I-70 Embankment

COUNTY St. Clair DRILLING METHOD 3.25" Hollow Stem Auger HAMMER TYPE CME Automatic

STRUCT. NO. n/a

Station: n/a

BORING NO. **EB-04**

Station: 147+75

Offset: Baseline

Ground Surface Elev. 412.5

DEPTH (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)	Surface Water Elev.	DEPTH (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)
				<u>n/a</u>				
				<u>n/a</u>				
				<u>n/a</u>				
				Groundwater Elevation:				
				First Encounter	<u>n/a</u>			
				Upon Completion	<u>n/a</u>			
				After 24 Hrs.	<u>n/a</u>			

SILTY CLAY—medium stiff (A-7)	372.0							
SAND—gray—medium dense (A-3)		2				7		
		7				8		
		5	NP	31		15	NP	16
	369.5							
SILTY CLAY—dark gray—medium stiff (A-7) Wet		10		<b>73</b>		10		
		5				12		
		-45	4	0.7B	48	-65	16	NP 17
	367.0							
SANDY LOAM—gray—medium dense (A-2)		4				10		
		10				14		
		11	NP	30		18	NP	19
	364.5							
SAND—brown—medium dense to dense (A-3)		8				8		
		12				15		
		-50	11	NP	20	-70	16	NP 19
		10				10		
		16				11		
		14	NP	23		12	NP	22
	339.5							
SAND & GRAVEL—brown—medium dense (A-1-b)		11				10		
		13				9		
		-55	12	NP	15	-75	10	NP 15
	337.0							
SAND—brown—dense (A-3)		5				8		
		5				11		
		7	NP	19		26	NP	14
		9				8		
		10				17		
		-60	11	NP	18	-80	17	NP 23

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS=Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery



Geo Services, Inc.  
 Geotechnical, Environmental & Civil Engineering  
 805 Amherst Court, Suite 204  
 Naperville, Illinois 60565  
 (630) 355-2838

# SOIL BORING LOG

PAGE 1 of 2

DATE 2/26/2009

LOGGED BY DR

GSJ JOB No. 08201

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION XX LOCATION I-70 Embankment

COUNTY St. Clair DRILLING METHOD 3.25" Hollow Stem Auger HAMMER TYPE CME Automatic

STRUCT. NO. n/a

Station: n/a

BORING NO. **EB-05**

Station: 153+56

Offset: Baseline

Ground Surface Elev. 412.0

DEPTH (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)	Surface Water Elev.	DEPTH (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)
				n/a				
				Groundwater Elevation:				
				First Encounter				
				Upon Completion				
				After 24 Hrs.				

DEPTH (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)	Soil Description	DEPTH (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)
411.5				TOPSOIL & WOOD CHIPS	391.5			
	AS	-	64					
	5			Miscellaneous Brick, Cinders & Gravel-loose (Fill)				
	3							
409.0	2	NP	16			ST	NP	1
	1			SAND-brown-medium dense (A-3)		4		
	1					7		
	-5	3	1.5P		-25	9	NP	19
	1			CLAY LOAM-dark brown & gray-stiff (A-6) Wet		9		
	1					7		
	2	1.5P	39			10	NP	19
					384.0			
	2					2		
	2			SILTY LOAM with Organics-dark gray-loose (A-4)		1		
	-10	3	1.3B		-30	7	NP	40
					381.5			
			98					
				SANDY LOAM-dark gray-very loose (A-2)		1		
						1		
						2	NP	30
398.5	ST	1.0P	34		379.0			
	0					4		
	1			SAND-gray-medium dense (A-3)		4		
	-15	1	0.7B		-35	12	NP	26
					376.0			
	1					8		
	1			SILTY CLAY-dark gray-soft (A-7) Wet		5		
	1	0.5P	40			3	0.25P	56
					374.0			
	0					6		
	1			SAND-gray-medium dense (A-3)		9		
	-20	1	0.7B		-40	5	NP	19

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST=Shelby Tube Sample VS=Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery

# SOIL BORING LOG

ROUTE I-70 DESCRIPTION I-70 Tri-Level Connection IDOT Job No. D-98-059-08

SECTION XX LOCATION I-70 Embankment

COUNTY St. Clair DRILLING METHOD 3.25" Hollow Stem Auger HAMMER TYPE CME Automatic

STRUCT. NO. n/a

Station: n/a

BORING NO. **EB-05**

Station: 153+56

Offset: Baseline

Ground Surface Elev. 412.0

DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)	Surface Water Elev.		DEPTH H (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)
				<u>n/a</u>	<u>n/a</u>				
				Stream Bed Elev.					
				<u>n/a</u>					
				Groundwater Elevation:					
				First Encounter					
				<u>n/a</u> ▼					
				Upon Completion					
				<u>n/a</u> ▼					
				After 24 Hrs.					
				<u>400.0</u> ▼					

SAND-gray-medium dense (A-3)										
		6					10			
		7					13			
	5	NP	19			13	NP	26		
	3						6			
	5						6			
	-45	6	NP	27		-65	10	NP	18	
					<i>366.5</i>					
SILTY LOAM-trace organics-dark gray-loose (A-4)										
		1					11			
		1					11			
	7	NP	40			11	NP	20		
					<i>364.0</i>					
SAND-gray-medium dense to very dense (A-3)										
		8					10			
		9					12			
		-50	10	NP	19		-70	13	NP	21
		8						6		
	13						14			
	10	NP	16				18	NP	17	
					<i>339.0</i>					
SAND & GRAVEL-brown & gray-medium dense to dense (A-1)										
		8					31			
		9					25			
		-55	13	NP	18		-75	19	NP	11
		14						12		
	29						7			
	33	NP	26				9	NP	14	
					<i>334.0</i>					
SAND-gray-medium dense (A-3) End Of Boring @ -80.0' Hollow Stem Augers To -10.0' Rotary Drilling To Completion CME Automatic Hammer										
		20					8			
		25					7			
		-60	26	NP	23		-80	8	NP	18

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer) ST-Shelby Tube Sample VS=Vane Shear Test  
 The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) The Unit Dry Weight (pcf) is noted in italics above moist (%)  
 NR-No Recovery

## **APPENDIX G**

# **KASKASKIA LIQUEFACTION POTENTIAL ANALYSIS**



# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-01** **1000 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **406.00** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **6.00** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.100** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.5** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.000</b>

Elev. of Sample (Feet)	Boring Data			Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
403.5	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	0.482	0.482	1.000	0.139	0.994	0.065	ABO. WAT.
401	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	0.757	0.757	1.000	0.126	0.989	0.064	ABO. WAT.
398.5	7.5	5	50	0.111	0.850	6.263	12.516	0.136	0.055	0.962	1.056	1.000	0.136	0.983	0.070	NL
396	10	2	50	0.049	1.050	2.316	7.779	0.094	0.049	1.092	1.342	1.000	0.094	0.977	0.078	NL
393.5	12.5	3	50	0.052	1.176	3.369	9.043	0.105	0.052	1.218	1.624	1.000	0.105	0.971	0.084	NL
391	15	5	14	0.055	1.310	5.457	7.893	0.095	0.055	1.352	1.914	1.000	0.095	0.966	0.089	1.067
388.5	17.5	14	6	0.064	1.459	14.844	14.943	0.159	0.064	1.501	2.219	1.000	0.159	0.960	0.092	1.728
386	20	19	6	0.067	1.623	19.570	19.692	0.212	0.067	1.665	2.539	1.000	0.212	0.954	0.095	2.232
383.5	22.5	17	6	0.066	1.789	17.078	17.188	0.183	0.066	1.831	2.861	1.000	0.183	0.948	0.096	1.906
381	25	16	6	0.065	1.953	15.744	15.848	0.169	0.065	1.995	3.181	1.000	0.169	0.943	0.098	1.724
378.5	27.5	24	6	0.069	2.121	23.180	23.319	0.262	0.069	2.163	3.505	0.996	0.261	0.937	0.099	2.636
376	30	32	6	0.071	2.296	29.862	30.032	1.000	0.071	2.338	3.836	0.981	0.981	0.931	0.099	N60cs>25
373.5	32.5	25	6	0.069	2.471	22.488	22.623	0.251	0.069	2.513	4.167	0.967	0.243	0.911	0.098	2.480
371	35	19	6	0.067	2.641	16.532	16.639	0.177	0.067	2.683	4.493	0.954	0.169	0.891	0.097	1.742
368.5	37.5	14	6	0.064	2.805	11.820	11.905	0.130	0.064	2.847	4.813	0.943	0.123	0.870	0.096	1.281
366	40	25	6	0.069	2.971	20.509	20.635	0.223	0.069	3.013	5.135	0.932	0.208	0.850	0.094	2.213
363.5	42.5	35	6	0.072	3.147	27.898	28.059	0.372	0.072	3.189	5.467	0.922	0.343	0.830	0.092	N60cs>25
361	45	20	6	0.067	3.321	15.518	15.621	0.166	0.067	3.363	5.797	0.912	0.151	0.810	0.091	1.659
358.5	47.5	19	6	0.067	3.489	14.383	14.480	0.155	0.067	3.531	6.121	0.903	0.140	0.789	0.089	1.573
356	50	40	6	0.074	3.665	29.544	29.712	0.449	0.074	3.707	6.453	0.894	0.401	0.769	0.087	N60cs>25
353.5	52.5	17	12	0.066	3.840	12.267	14.208	0.152	0.066	3.882	6.784	0.886	0.135	0.749	0.085	1.588
351	55	7	6	0.058	3.995	4.952	5.005	0.072	0.058	4.037	7.095	0.879	0.063	0.729	0.083	0.759
348.5	57.5	9	6	0.060	4.143	6.052	6.110	0.081	0.060	4.185	7.399	0.873	0.071	0.708	0.081	0.877
346	60	14	6	0.064	4.298	9.197	9.270	0.107	0.064	4.340	7.710	0.867	0.093	0.688	0.079	1.177
343.5	62.5	21	6	0.068	4.463	13.463	13.556	0.146	0.068	4.505	8.031	0.860	0.126	0.668	0.077	1.636
341	65	33	6	0.072	4.638	20.631	20.758	0.225	0.072	4.680	8.362	0.854	0.192	0.648	0.075	2.560
338.5	67.5	28	6	0.070	4.816	17.073	17.183	0.183	0.070	4.858	8.696	0.847	0.155	0.627	0.073	2.123
336	70	28	6	0.070	4.991	16.669	16.777	0.178	0.070	5.033	9.027	0.841	0.150	0.607	0.071	2.113
333.5	72.5	31	6	0.071	5.167	18.026	18.140	0.193	0.071	5.209	9.359	0.835	0.161	0.587	0.069	2.333
331	75	25	6	0.069	5.342	14.208	14.304	0.153	0.069	5.384	9.690	0.830	0.127	0.567	0.066	1.924
328.5	77.5	27	12	0.070	5.516	15.008	17.035	0.181	0.070	5.558	10.020	0.825	0.149	0.546	0.064	2.328
326	80	28	12	0.070	5.691	15.227	17.261	0.184	0.070	5.733	10.351	0.820	0.151	0.526	0.062	2.435

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction



# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-01** **1000 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **406.00** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **6.00** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.190** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **5.6** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 2.112</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
403.5	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	0.482	0.482	2.112	0.294	0.994	0.123	ABO. WAT.
401	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	0.757	0.757	2.112	0.266	0.989	0.122	ABO. WAT.
398.5	7.5	5	50	0.111	0.850	6.263	12.516	0.136	0.055	0.962	1.056	2.112	0.287	0.983	0.133	NL
396	10	2	50	0.049	1.050	2.316	7.779	0.094	0.049	1.092	1.342	2.112	0.199	0.977	0.148	NL
393.5	12.5	3	50	0.052	1.176	3.369	9.043	0.105	0.052	1.218	1.624	2.112	0.222	0.971	0.160	NL
391	15	5	14	0.055	1.310	5.457	7.893	0.095	0.055	1.352	1.914	2.112	0.201	0.966	0.169	1.189
388.5	17.5	14	6	0.064	1.459	14.844	14.943	0.159	0.064	1.501	2.219	2.112	0.336	0.960	0.175	1.920
386	20	19	6	0.067	1.623	19.570	19.692	0.212	0.067	1.665	2.539	2.112	0.448	0.954	0.180	2.489
383.5	22.5	17	6	0.066	1.789	17.078	17.188	0.183	0.066	1.831	2.861	2.112	0.386	0.948	0.183	2.109
381	25	16	6	0.065	1.953	15.744	15.848	0.169	0.065	1.995	3.181	2.112	0.357	0.943	0.186	1.919
378.5	27.5	24	6	0.069	2.121	23.180	23.319	0.262	0.069	2.163	3.505	2.104	0.551	0.937	0.188	2.931
376	30	32	6	0.071	2.296	29.862	30.032	1.000	0.071	2.338	3.836	2.071	2.071	0.931	0.189	N60cs>25
373.5	32.5	25	6	0.069	2.471	22.488	22.623	0.251	0.069	2.513	4.167	2.041	0.512	0.911	0.187	2.738
371	35	19	6	0.067	2.641	16.532	16.639	0.177	0.067	2.683	4.493	2.015	0.357	0.891	0.184	1.940
368.5	37.5	14	6	0.064	2.805	11.820	11.905	0.130	0.064	2.847	4.813	1.991	0.259	0.870	0.182	1.423
366	40	25	6	0.069	2.971	20.509	20.635	0.223	0.069	3.013	5.135	1.969	0.439	0.850	0.179	2.453
363.5	42.5	35	6	0.072	3.147	27.898	28.059	0.372	0.072	3.189	5.467	1.946	0.724	0.830	0.176	N60cs>25
361	45	20	6	0.067	3.321	15.518	15.621	0.166	0.067	3.363	5.797	1.926	0.320	0.810	0.172	1.860
358.5	47.5	19	6	0.067	3.489	14.383	14.480	0.155	0.067	3.531	6.121	1.907	0.296	0.789	0.169	1.751
356	50	40	6	0.074	3.665	29.544	29.712	0.449	0.074	3.707	6.453	1.889	0.848	0.769	0.165	N60cs>25
353.5	52.5	17	12	0.066	3.840	12.267	14.208	0.152	0.066	3.882	6.784	1.871	0.284	0.749	0.162	1.753
351	55	7	6	0.058	3.995	4.952	5.005	0.072	0.058	4.037	7.095	1.857	0.134	0.729	0.158	0.848
348.5	57.5	9	6	0.060	4.143	6.052	6.110	0.081	0.060	4.185	7.399	1.843	0.149	0.708	0.155	0.961
346	60	14	6	0.064	4.298	9.197	9.270	0.107	0.064	4.340	7.710	1.830	0.196	0.688	0.151	1.298
343.5	62.5	21	6	0.068	4.463	13.463	13.556	0.146	0.068	4.505	8.031	1.816	0.265	0.668	0.147	1.803
341	65	33	6	0.072	4.638	20.631	20.758	0.225	0.072	4.680	8.362	1.803	0.406	0.648	0.143	2.839
338.5	67.5	28	6	0.070	4.816	17.073	17.183	0.183	0.070	4.858	8.696	1.789	0.327	0.627	0.139	2.353
336	70	28	6	0.070	4.991	16.669	16.777	0.178	0.070	5.033	9.027	1.777	0.316	0.607	0.134	2.358
333.5	72.5	31	6	0.071	5.167	18.026	18.140	0.193	0.071	5.209	9.359	1.764	0.340	0.587	0.130	2.615
331	75	25	6	0.069	5.342	14.208	14.304	0.153	0.069	5.384	9.690	1.753	0.268	0.567	0.126	2.127
328.5	77.5	27	12	0.070	5.516	15.008	17.035	0.181	0.070	5.558	10.020	1.742	0.315	0.546	0.122	2.582
326	80	28	12	0.070	5.691	15.227	17.261	0.184	0.070	5.733	10.351	1.731	0.319	0.526	0.117	2.726

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-01** **2500 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **406.00** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **6.00** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.110** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.7** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 0.935</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
403.5	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	0.482	0.482	0.935	0.130	0.994	0.071	ABO. WAT.	
401	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	0.757	0.757	0.935	0.118	0.989	0.071	ABO. WAT.	
398.5	7.5	5	50	0.111	0.850	6.263	12.516	0.136	0.055	0.962	1.056	0.935	0.127	0.983	0.077	NL	
396	10	2	50	0.049	1.050	2.316	7.779	0.094	0.049	1.092	1.342	0.935	0.088	0.977	0.086	NL	
393.5	12.5	3	50	0.052	1.176	3.369	9.043	0.105	0.052	1.218	1.624	0.935	0.098	0.971	0.093	NL	
391	15	5	14	0.055	1.310	5.457	7.893	0.095	0.055	1.352	1.914	0.935	0.089	0.966	0.098	0.908	
388.5	17.5	14	6	0.064	1.459	14.844	14.943	0.159	0.064	1.501	2.219	0.935	0.149	0.960	0.101	1.475	
386	20	19	6	0.067	1.623	19.570	19.692	0.212	0.067	1.665	2.539	0.935	0.198	0.954	0.104	1.904	
383.5	22.5	17	6	0.066	1.789	17.078	17.188	0.183	0.066	1.831	2.861	0.935	0.171	0.948	0.106	1.613	
381	25	16	6	0.065	1.953	15.744	15.848	0.169	0.065	1.995	3.181	0.935	0.158	0.943	0.108	1.463	
378.5	27.5	24	6	0.069	2.121	23.180	23.319	0.262	0.069	2.163	3.505	0.931	0.244	0.937	0.109	2.239	
376	30	32	6	0.071	2.296	29.862	30.032	1.000	0.071	2.338	3.836	0.917	0.917	0.931	0.109	N60cs>25	
373.5	32.5	25	6	0.069	2.471	22.488	22.623	0.251	0.069	2.513	4.167	0.904	0.227	0.911	0.108	2.102	
371	35	19	6	0.067	2.641	16.532	16.639	0.177	0.067	2.683	4.493	0.892	0.158	0.891	0.107	1.477	
368.5	37.5	14	6	0.064	2.805	11.820	11.905	0.130	0.064	2.847	4.813	0.881	0.115	0.870	0.105	1.095	
366	40	25	6	0.069	2.971	20.509	20.635	0.223	0.069	3.013	5.135	0.872	0.194	0.850	0.104	1.865	
363.5	42.5	35	6	0.072	3.147	27.898	28.059	0.372	0.072	3.189	5.467	0.862	0.321	0.830	0.102	N60cs>25	
361	45	20	6	0.067	3.321	15.518	15.621	0.166	0.067	3.363	5.797	0.853	0.142	0.810	0.100	1.420	
358.5	47.5	19	6	0.067	3.489	14.383	14.480	0.155	0.067	3.531	6.121	0.844	0.131	0.789	0.098	1.337	
356	50	40	6	0.074	3.665	29.544	29.712	0.449	0.074	3.707	6.453	0.836	0.375	0.769	0.096	N60cs>25	
353.5	52.5	17	12	0.066	3.840	12.267	14.208	0.152	0.066	3.882	6.784	0.828	0.126	0.749	0.094	1.340	
351	55	7	6	0.058	3.995	4.952	5.005	0.072	0.058	4.037	7.095	0.822	0.059	0.729	0.092	0.641	
348.5	57.5	9	6	0.060	4.143	6.052	6.110	0.081	0.060	4.185	7.399	0.816	0.066	0.708	0.089	0.742	
346	60	14	6	0.064	4.298	9.197	9.270	0.107	0.064	4.340	7.710	0.810	0.087	0.688	0.087	1.000	
343.5	62.5	21	6	0.068	4.463	13.463	13.556	0.146	0.068	4.505	8.031	0.804	0.117	0.668	0.085	1.376	
341	65	33	6	0.072	4.638	20.631	20.758	0.225	0.072	4.680	8.362	0.798	0.180	0.648	0.083	2.169	
338.5	67.5	28	6	0.070	4.816	17.073	17.183	0.183	0.070	4.858	8.696	0.792	0.145	0.627	0.080	1.813	
336	70	28	6	0.070	4.991	16.669	16.777	0.178	0.070	5.033	9.027	0.787	0.140	0.607	0.078	1.795	
333.5	72.5	31	6	0.071	5.167	18.026	18.140	0.193	0.071	5.209	9.359	0.781	0.151	0.587	0.075	2.013	
331	75	25	6	0.069	5.342	14.208	14.304	0.153	0.069	5.384	9.690	0.776	0.119	0.567	0.073	1.630	
328.5	77.5	27	12	0.070	5.516	15.008	17.035	0.181	0.070	5.558	10.020	0.771	0.140	0.546	0.070	2.000	
326	80	28	12	0.070	5.691	15.227	17.261	0.184	0.070	5.733	10.351	0.766	0.141	0.526	0.068	2.074	

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-01** **2500 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **406.00** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **6.00** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.270** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **6.0** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.770</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
403.5	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	0.482	0.482	1.770	0.246	0.994	0.174	ABO. WAT.
401	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	0.757	0.757	1.770	0.223	0.989	0.174	ABO. WAT.
398.5	7.5	5	50	0.111	0.850	6.263	12.516	0.136	0.055	0.962	1.056	1.770	0.241	0.983	0.189	NL
396	10	2	50	0.049	1.050	2.316	7.779	0.094	0.049	1.092	1.342	1.770	0.166	0.977	0.211	NL
393.5	12.5	3	50	0.052	1.176	3.369	9.043	0.105	0.052	1.218	1.624	1.770	0.186	0.971	0.227	NL
391	15	5	14	0.055	1.310	5.457	7.893	0.095	0.055	1.352	1.914	1.770	0.168	0.966	0.240	0.700
388.5	17.5	14	6	0.064	1.459	14.844	14.943	0.159	0.064	1.501	2.219	1.770	0.281	0.960	0.249	1.129
386	20	19	6	0.067	1.623	19.570	19.692	0.212	0.067	1.665	2.539	1.770	0.375	0.954	0.255	1.471
383.5	22.5	17	6	0.066	1.789	17.078	17.188	0.183	0.066	1.831	2.861	1.770	0.324	0.948	0.260	1.246
381	25	16	6	0.065	1.953	15.744	15.848	0.169	0.065	1.995	3.181	1.770	0.299	0.943	0.264	1.133
378.5	27.5	24	6	0.069	2.121	23.180	23.319	0.262	0.069	2.163	3.505	1.763	0.462	0.937	0.266	1.737
376	30	32	6	0.071	2.296	29.862	30.032	1.000	0.071	2.338	3.836	1.736	1.736	0.931	0.268	N60cs>25
373.5	32.5	25	6	0.069	2.471	22.488	22.623	0.251	0.069	2.513	4.167	1.711	0.429	0.911	0.265	1.619
371	35	19	6	0.067	2.641	16.532	16.639	0.177	0.067	2.683	4.493	1.689	0.299	0.891	0.262	1.141
368.5	37.5	14	6	0.064	2.805	11.820	11.905	0.130	0.064	2.847	4.813	1.669	0.217	0.870	0.258	0.841
366	40	25	6	0.069	2.971	20.509	20.635	0.223	0.069	3.013	5.135	1.650	0.368	0.850	0.254	1.449
363.5	42.5	35	6	0.072	3.147	27.898	28.059	0.372	0.072	3.189	5.467	1.631	0.607	0.830	0.250	N60cs>25
361	45	20	6	0.067	3.321	15.518	15.621	0.166	0.067	3.363	5.797	1.614	0.268	0.810	0.245	1.094
358.5	47.5	19	6	0.067	3.489	14.383	14.480	0.155	0.067	3.531	6.121	1.598	0.248	0.789	0.240	1.033
356	50	40	6	0.074	3.665	29.544	29.712	0.449	0.074	3.707	6.453	1.583	0.711	0.769	0.235	N60cs>25
353.5	52.5	17	12	0.066	3.840	12.267	14.208	0.152	0.066	3.882	6.784	1.568	0.238	0.749	0.230	1.035
351	55	7	6	0.058	3.995	4.952	5.005	0.072	0.058	4.037	7.095	1.556	0.112	0.729	0.225	0.498
348.5	57.5	9	6	0.060	4.143	6.052	6.110	0.081	0.060	4.185	7.399	1.545	0.125	0.708	0.220	0.568
346	60	14	6	0.064	4.298	9.197	9.270	0.107	0.064	4.340	7.710	1.534	0.164	0.688	0.215	0.763
343.5	62.5	21	6	0.068	4.463	13.463	13.556	0.146	0.068	4.505	8.031	1.522	0.222	0.668	0.209	1.062
341	65	33	6	0.072	4.638	20.631	20.758	0.225	0.072	4.680	8.362	1.511	0.340	0.648	0.203	1.675
338.5	67.5	28	6	0.070	4.816	17.073	17.183	0.183	0.070	4.858	8.696	1.500	0.275	0.627	0.197	1.396
336	70	28	6	0.070	4.991	16.669	16.777	0.178	0.070	5.033	9.027	1.489	0.265	0.607	0.191	1.387
333.5	72.5	31	6	0.071	5.167	18.026	18.140	0.193	0.071	5.209	9.359	1.479	0.285	0.587	0.185	1.541
331	75	25	6	0.069	5.342	14.208	14.304	0.153	0.069	5.384	9.690	1.469	0.225	0.567	0.179	1.257
328.5	77.5	27	12	0.070	5.516	15.008	17.035	0.181	0.070	5.558	10.020	1.460	0.264	0.546	0.173	1.526
326	80	28	12	0.070	5.691	15.227	17.261	0.184	0.070	5.733	10.351	1.451	0.267	0.526	0.167	1.599

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-02** **1000 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **406.00** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **6.00** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.100** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.5** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.000</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
403.5	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	0.482	0.482	1.000	0.139	0.994	0.065	ABO. WAT.	
401	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	0.757	0.757	1.000	0.126	0.989	0.064	ABO. WAT.	
398.5	7.5	2	50	0.102	0.839	2.522	8.026	0.096	0.049	0.955	1.049	1.000	0.096	0.983	0.070	NL	
396	10	2	50	0.049	1.028	2.340	7.808	0.094	0.049	1.078	1.328	1.000	0.094	0.977	0.078	NL	
393.5	12.5	5	35	0.055	1.158	5.658	11.790	0.129	0.055	1.208	1.614	1.000	0.129	0.971	0.084	1.536	
391	15	11	6	0.062	1.304	12.034	12.120	0.132	0.062	1.354	1.916	1.000	0.132	0.966	0.089	1.483	
388.5	17.5	13	6	0.063	1.460	13.779	13.873	0.149	0.063	1.510	2.228	1.000	0.149	0.960	0.092	1.620	
386	20	16	6	0.065	1.620	16.495	16.602	0.177	0.065	1.670	2.544	1.000	0.177	0.954	0.094	1.883	
383.5	22.5	13	6	0.063	1.780	13.092	13.183	0.142	0.063	1.830	2.860	1.000	0.142	0.948	0.096	1.479	
381	25	15	6	0.065	1.940	14.809	14.908	0.159	0.065	1.990	3.176	1.000	0.159	0.943	0.098	1.622	
378.5	27.5	32	6	0.071	2.110	30.986	31.161	1.000	0.071	2.160	3.502	0.996	0.996	0.937	0.099	N60cs>25	
376	30	26	6	0.070	2.286	24.316	24.460	0.282	0.070	2.336	3.834	0.981	0.277	0.931	0.099	2.798	
373.5	32.5	25	6	0.069	2.460	22.538	22.674	0.252	0.069	2.510	4.164	0.967	0.244	0.911	0.098	2.490	
371	35	17	6	0.066	2.629	14.825	14.924	0.159	0.066	2.679	4.489	0.954	0.152	0.891	0.097	1.567	
368.5	37.5	17	6	0.066	2.794	14.381	14.478	0.155	0.066	2.844	4.810	0.943	0.146	0.870	0.096	1.521	
366	40	26	6	0.070	2.964	21.354	21.484	0.235	0.070	3.014	5.136	0.932	0.219	0.850	0.094	2.330	
363.5	42.5	22	6	0.068	3.137	17.564	17.676	0.188	0.068	3.187	5.465	0.922	0.173	0.830	0.093	1.860	
361	45	36	6	0.073	3.313	27.967	28.128	0.374	0.073	3.363	5.797	0.912	0.341	0.810	0.091	N60cs>25	
358.5	47.5	31	6	0.071	3.493	23.454	23.594	0.267	0.071	3.543	6.133	0.902	0.241	0.789	0.089	2.708	
356	50	27	6	0.070	3.669	19.931	20.054	0.216	0.070	3.719	6.465	0.894	0.193	0.769	0.087	2.218	
353.5	52.5	27	6	0.070	3.844	19.472	19.593	0.210	0.070	3.894	6.796	0.885	0.186	0.749	0.085	2.188	
351	55	12	12	0.063	4.010	8.237	10.051	0.114	0.063	4.060	7.118	0.878	0.100	0.729	0.083	1.205	
348.5	57.5	30	6	0.071	4.178	20.067	20.191	0.218	0.071	4.228	7.442	0.871	0.190	0.708	0.081	2.346	
346	60	29	6	0.071	4.356	18.887	19.005	0.203	0.071	4.406	7.776	0.864	0.175	0.688	0.079	2.215	
343.5	62.5	29	6	0.071	4.534	18.402	18.518	0.198	0.071	4.584	8.110	0.857	0.170	0.668	0.077	2.208	
341	65	39	6	0.073	4.714	24.121	24.264	0.278	0.073	4.764	8.446	0.850	0.236	0.648	0.075	3.147	
338.5	67.5	16	6	0.065	4.887	9.661	9.736	0.111	0.065	4.937	8.775	0.844	0.094	0.627	0.072	1.306	
336	70	26	6	0.070	5.056	15.343	15.445	0.165	0.070	5.106	9.100	0.839	0.138	0.607	0.070	1.971	
333.5	72.5	30	6	0.071	5.232	17.296	17.407	0.185	0.071	5.282	9.432	0.833	0.154	0.587	0.068	2.265	
331	75	48	6	0.075	5.415	27.025	27.182	0.344	0.075	5.465	9.771	0.827	0.284	0.567	0.066	N60cs>25	
328.5	77.5	62	6	0.078	5.606	34.074	34.264	1.000	0.078	5.656	10.118	0.822	0.822	0.546	0.063	N60cs>25	
326	80	32	12	0.071	5.792	17.188	19.284	0.207	0.071	5.842	10.460	0.816	0.169	0.526	0.061	2.770	

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-02** **1000 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **406.00** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **6.00** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.190** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **5.6** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor	<b>(K<math>\alpha</math>)= 1.00</b>
Earthquake Magnitude Scaling Factor	<b>(MSF)= 2.112</b>

Elev. of Sample (Feet)	Boring Data			Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K $\sigma$ )(K $\alpha$ )(MSF)				
403.5	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	0.482	0.482	2.112	<b>0.294</b>	0.994	<b>0.123</b>	<b>ABO. WAT.</b>
401	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	0.757	0.757	2.112	<b>0.266</b>	0.989	<b>0.122</b>	<b>ABO. WAT.</b>
398.5	7.5	2	50	0.102	0.839	2.522	8.026	0.096	0.049	0.955	1.049	2.112	<b>0.203</b>	0.983	<b>0.133</b>	<b>NL</b>
396	10	2	50	0.049	1.028	2.340	7.808	0.094	0.049	1.078	1.328	2.112	<b>0.199</b>	0.977	<b>0.149</b>	<b>NL</b>
393.5	12.5	5	35	0.055	1.158	5.658	11.790	0.129	0.055	1.208	1.614	2.112	<b>0.272</b>	0.971	<b>0.160</b>	<b>1.700</b>
391	15	11	6	0.062	1.304	12.034	12.120	0.132	0.062	1.354	1.916	2.112	<b>0.279</b>	0.966	<b>0.169</b>	<b>1.651</b>
388.5	17.5	13	6	0.063	1.460	13.779	13.873	0.149	0.063	1.510	2.228	2.112	<b>0.315</b>	0.960	<b>0.175</b>	<b>1.800</b>
386	20	16	6	0.065	1.620	16.495	16.602	0.177	0.065	1.670	2.544	2.112	<b>0.374</b>	0.954	<b>0.179</b>	<b>2.089</b>
383.5	22.5	13	6	0.063	1.780	13.092	13.183	0.142	0.063	1.830	2.860	2.112	<b>0.300</b>	0.948	<b>0.183</b>	<b>1.639</b>
381	25	15	6	0.065	1.940	14.809	14.908	0.159	0.065	1.990	3.176	2.112	<b>0.336</b>	0.943	<b>0.186</b>	<b>1.806</b>
378.5	27.5	32	6	0.071	2.110	30.986	31.161	1.000	0.071	2.160	3.502	2.104	<b>2.104</b>	0.937	<b>0.188</b>	<b>N60cs&gt;25</b>
376	30	26	6	0.070	2.286	24.316	24.460	0.282	0.070	2.336	3.834	2.071	<b>0.584</b>	0.931	<b>0.189</b>	<b>3.090</b>
373.5	32.5	25	6	0.069	2.460	22.538	22.674	0.252	0.069	2.510	4.164	2.042	<b>0.515</b>	0.911	<b>0.187</b>	<b>2.754</b>
371	35	17	6	0.066	2.629	14.825	14.924	0.159	0.066	2.679	4.489	2.015	<b>0.320</b>	0.891	<b>0.184</b>	<b>1.739</b>
368.5	37.5	17	6	0.066	2.794	14.381	14.478	0.155	0.066	2.844	4.810	1.991	<b>0.309</b>	0.870	<b>0.182</b>	<b>1.698</b>
366	40	26	6	0.070	2.964	21.354	21.484	0.235	0.070	3.014	5.136	1.968	<b>0.462</b>	0.850	<b>0.179</b>	<b>2.581</b>
363.5	42.5	22	6	0.068	3.137	17.564	17.676	0.188	0.068	3.187	5.465	1.947	<b>0.366</b>	0.830	<b>0.176</b>	<b>2.080</b>
361	45	36	6	0.073	3.313	27.967	28.128	0.374	0.073	3.363	5.797	1.926	<b>0.720</b>	0.810	<b>0.172</b>	<b>N60cs&gt;25</b>
358.5	47.5	31	6	0.071	3.493	23.454	23.594	0.267	0.071	3.543	6.133	1.906	<b>0.509</b>	0.789	<b>0.169</b>	<b>3.012</b>
356	50	27	6	0.070	3.669	19.931	20.054	0.216	0.070	3.719	6.465	1.887	<b>0.408</b>	0.769	<b>0.165</b>	<b>2.473</b>
353.5	52.5	27	6	0.070	3.844	19.472	19.593	0.210	0.070	3.894	6.796	1.870	<b>0.393</b>	0.749	<b>0.161</b>	<b>2.441</b>
351	55	12	12	0.063	4.010	8.237	10.051	0.114	0.063	4.060	7.118	1.855	<b>0.211</b>	0.729	<b>0.158</b>	<b>1.335</b>
348.5	57.5	30	6	0.071	4.178	20.067	20.191	0.218	0.071	4.228	7.442	1.840	<b>0.401</b>	0.708	<b>0.154</b>	<b>2.604</b>
346	60	29	6	0.071	4.356	18.887	19.005	0.203	0.071	4.406	7.776	1.825	<b>0.370</b>	0.688	<b>0.150</b>	<b>2.467</b>
343.5	62.5	29	6	0.071	4.534	18.402	18.518	0.198	0.071	4.584	8.110	1.810	<b>0.358</b>	0.668	<b>0.146</b>	<b>2.452</b>
341	65	39	6	0.073	4.714	24.121	24.264	0.278	0.073	4.764	8.446	1.796	<b>0.499</b>	0.648	<b>0.142</b>	<b>3.514</b>
338.5	67.5	16	6	0.065	4.887	9.661	9.736	0.111	0.065	4.937	8.775	1.783	<b>0.198</b>	0.627	<b>0.138</b>	<b>1.435</b>
336	70	26	6	0.070	5.056	15.343	15.445	0.165	0.070	5.106	9.100	1.772	<b>0.292</b>	0.607	<b>0.134</b>	<b>2.179</b>
333.5	72.5	30	6	0.071	5.232	17.296	17.407	0.185	0.071	5.282	9.432	1.760	<b>0.326</b>	0.587	<b>0.129</b>	<b>2.527</b>
331	75	48	6	0.075	5.415	27.025	27.182	0.344	0.075	5.465	9.771	1.748	<b>0.601</b>	0.567	<b>0.125</b>	<b>N60cs&gt;25</b>
328.5	77.5	62	6	0.078	5.606	34.074	34.264	1.000	0.078	5.656	10.118	1.736	<b>1.736</b>	0.546	<b>0.121</b>	<b>N60cs&gt;25</b>
326	80	32	12	0.071	5.792	17.188	19.284	0.207	0.071	5.842	10.460	1.724	<b>0.357</b>	0.526	<b>0.116</b>	<b>3.078</b>

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-02 **2500 Long period**

ELEVATION OF BORING GROUND SURFACE ===== 406.00 FT.

DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)

DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 6.00 FT. (Below Finished Grade Cut or Fill Surface)

MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.110 Coefficient of Gravity

DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 7.7 Moment Magnitude Scale

FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 0.00 FT. (Which is 0 ksf Effect. Surch. Fill Press.)

ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground
Shear Stress
Correct. Factor
<b>(K<sub>α</sub>)=</b> 1.00
Earthquake
Magnitude
Scaling Factor
<b>(MSF)=</b> 0.935

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> )60	Fines Content Corrected (N <sub>1</sub> )60cs	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
403.5	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	0.482	0.482	0.935	0.130	0.994	0.071	ABO. WAT.	
401	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	0.757	0.757	0.935	0.118	0.989	0.071	ABO. WAT.	
398.5	7.5	2	50	0.102	0.839	2.522	8.026	0.096	0.049	0.955	1.049	0.935	0.090	0.983	0.077	NL	
396	10	2	50	0.049	1.028	2.340	7.808	0.094	0.049	1.078	1.328	0.935	0.088	0.977	0.086	NL	
393.5	12.5	5	35	0.055	1.158	5.658	11.790	0.129	0.055	1.208	1.614	0.935	0.121	0.971	0.093	1.301	
391	15	11	6	0.062	1.304	12.034	12.120	0.132	0.062	1.354	1.916	0.935	0.123	0.966	0.098	1.255	
388.5	17.5	13	6	0.063	1.460	13.779	13.873	0.149	0.063	1.510	2.228	0.935	0.139	0.960	0.101	1.376	
386	20	16	6	0.065	1.620	16.495	16.602	0.177	0.065	1.670	2.544	0.935	0.165	0.954	0.104	1.587	
383.5	22.5	13	6	0.063	1.780	13.092	13.183	0.142	0.063	1.830	2.860	0.935	0.133	0.948	0.106	1.255	
381	25	15	6	0.065	1.940	14.809	14.908	0.159	0.065	1.990	3.176	0.935	0.149	0.943	0.108	1.380	
378.5	27.5	32	6	0.071	2.110	30.986	31.161	1.000	0.071	2.160	3.502	0.932	0.932	0.937	0.109	N60cs>25	
376	30	26	6	0.070	2.286	24.316	24.460	0.282	0.070	2.336	3.834	0.917	0.259	0.931	0.109	2.376	
373.5	32.5	25	6	0.069	2.460	22.538	22.674	0.252	0.069	2.510	4.164	0.904	0.228	0.911	0.108	2.111	
371	35	17	6	0.066	2.629	14.825	14.924	0.159	0.066	2.679	4.489	0.892	0.142	0.891	0.107	1.327	
368.5	37.5	17	6	0.066	2.794	14.381	14.478	0.155	0.066	2.844	4.810	0.882	0.137	0.870	0.105	1.305	
366	40	26	6	0.070	2.964	21.354	21.484	0.235	0.070	3.014	5.136	0.871	0.205	0.850	0.104	1.971	
363.5	42.5	22	6	0.068	3.137	17.564	17.676	0.188	0.068	3.187	5.465	0.862	0.162	0.830	0.102	1.588	
361	45	36	6	0.073	3.313	27.967	28.128	0.374	0.073	3.363	5.797	0.853	0.319	0.810	0.100	N60cs>25	
358.5	47.5	31	6	0.071	3.493	23.454	23.594	0.267	0.071	3.543	6.133	0.844	0.225	0.789	0.098	2.296	
356	50	27	6	0.070	3.669	19.931	20.054	0.216	0.070	3.719	6.465	0.836	0.181	0.769	0.096	1.885	
353.5	52.5	27	6	0.070	3.844	19.472	19.593	0.210	0.070	3.894	6.796	0.828	0.174	0.749	0.093	1.871	
351	55	12	12	0.063	4.010	8.237	10.051	0.114	0.063	4.060	7.118	0.821	0.094	0.729	0.091	1.033	
348.5	57.5	30	6	0.071	4.178	20.067	20.191	0.218	0.071	4.228	7.442	0.814	0.177	0.708	0.089	1.989	
346	60	29	6	0.071	4.356	18.887	19.005	0.203	0.071	4.406	7.776	0.808	0.164	0.688	0.087	1.885	
343.5	62.5	29	6	0.071	4.534	18.402	18.518	0.198	0.071	4.584	8.110	0.801	0.159	0.668	0.085	1.871	
341	65	39	6	0.073	4.714	24.121	24.264	0.278	0.073	4.764	8.446	0.795	0.221	0.648	0.082	2.695	
338.5	67.5	16	6	0.065	4.887	9.661	9.736	0.111	0.065	4.937	8.775	0.790	0.088	0.627	0.080	1.100	
336	70	26	6	0.070	5.056	15.343	15.445	0.165	0.070	5.106	9.100	0.784	0.129	0.607	0.077	1.675	
333.5	72.5	30	6	0.071	5.232	17.296	17.407	0.185	0.071	5.282	9.432	0.779	0.144	0.587	0.075	1.920	
331	75	48	6	0.075	5.415	27.025	27.182	0.344	0.075	5.465	9.771	0.774	0.266	0.567	0.072	N60cs>25	
328.5	77.5	62	6	0.078	5.606	34.074	34.264	1.000	0.078	5.656	10.118	0.768	0.768	0.546	0.070	N60cs>25	
326	80	32	12	0.071	5.792	17.188	19.284	0.207	0.071	5.842	10.460	0.763	0.158	0.526	0.067	2.358	

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-02** **2500 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **406.00** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **6.00** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.270** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **6.0** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.770</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)		Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)				
403.5	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	0.482	0.482	1.770	0.246	0.994	0.174	ABO. WAT.
401	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	0.757	0.757	1.770	0.223	0.989	0.174	ABO. WAT.
398.5	7.5	2	50	0.102	0.839	2.522	8.026	0.096	0.049	0.955	1.049	1.770	0.170	0.983	0.189	NL
396	10	2	50	0.049	1.028	2.340	7.808	0.094	0.049	1.078	1.328	1.770	0.166	0.977	0.211	NL
393.5	12.5	5	35	0.055	1.158	5.658	11.790	0.129	0.055	1.208	1.614	1.770	0.228	0.971	0.228	1.000
391	15	11	6	0.062	1.304	12.034	12.120	0.132	0.062	1.354	1.916	1.770	0.234	0.966	0.240	0.975
388.5	17.5	13	6	0.063	1.460	13.779	13.873	0.149	0.063	1.510	2.228	1.770	0.264	0.960	0.249	1.060
386	20	16	6	0.065	1.620	16.495	16.602	0.177	0.065	1.670	2.544	1.770	0.313	0.954	0.255	1.227
383.5	22.5	13	6	0.063	1.780	13.092	13.183	0.142	0.063	1.830	2.860	1.770	0.251	0.948	0.260	0.965
381	25	15	6	0.065	1.940	14.809	14.908	0.159	0.065	1.990	3.176	1.770	0.281	0.943	0.264	1.064
378.5	27.5	32	6	0.071	2.110	30.986	31.161	1.000	0.071	2.160	3.502	1.763	1.763	0.937	0.267	N60cs>25
376	30	26	6	0.070	2.286	24.316	24.460	0.282	0.070	2.336	3.834	1.736	0.490	0.931	0.268	1.828
373.5	32.5	25	6	0.069	2.460	22.538	22.674	0.252	0.069	2.510	4.164	1.711	0.431	0.911	0.265	1.626
371	35	17	6	0.066	2.629	14.825	14.924	0.159	0.066	2.679	4.489	1.689	0.269	0.891	0.262	1.027
368.5	37.5	17	6	0.066	2.794	14.381	14.478	0.155	0.066	2.844	4.810	1.669	0.259	0.870	0.258	1.004
366	40	26	6	0.070	2.964	21.354	21.484	0.235	0.070	3.014	5.136	1.650	0.388	0.850	0.254	1.528
363.5	42.5	22	6	0.068	3.137	17.564	17.676	0.188	0.068	3.187	5.465	1.631	0.307	0.830	0.250	1.228
361	45	36	6	0.073	3.313	27.967	28.128	0.374	0.073	3.363	5.797	1.614	0.604	0.810	0.245	N60cs>25
358.5	47.5	31	6	0.071	3.493	23.454	23.594	0.267	0.071	3.543	6.133	1.597	0.426	0.789	0.240	1.775
356	50	27	6	0.070	3.669	19.931	20.054	0.216	0.070	3.719	6.465	1.582	0.342	0.769	0.235	1.455
353.5	52.5	27	6	0.070	3.844	19.472	19.593	0.210	0.070	3.894	6.796	1.567	0.329	0.749	0.229	1.437
351	55	12	12	0.063	4.010	8.237	10.051	0.114	0.063	4.060	7.118	1.554	0.177	0.729	0.224	0.790
348.5	57.5	30	6	0.071	4.178	20.067	20.191	0.218	0.071	4.228	7.442	1.542	0.336	0.708	0.219	1.534
346	60	29	6	0.071	4.356	18.887	19.005	0.203	0.071	4.406	7.776	1.529	0.310	0.688	0.213	1.455
343.5	62.5	29	6	0.071	4.534	18.402	18.518	0.198	0.071	4.584	8.110	1.517	0.300	0.668	0.207	1.449
341	65	39	6	0.073	4.714	24.121	24.264	0.278	0.073	4.764	8.446	1.505	0.418	0.648	0.202	2.069
338.5	67.5	16	6	0.065	4.887	9.661	9.736	0.111	0.065	4.937	8.775	1.495	0.166	0.627	0.196	0.847
336	70	26	6	0.070	5.056	15.343	15.445	0.165	0.070	5.106	9.100	1.485	0.245	0.607	0.190	1.289
333.5	72.5	30	6	0.071	5.232	17.296	17.407	0.185	0.071	5.282	9.432	1.475	0.273	0.587	0.184	1.484
331	75	48	6	0.075	5.415	27.025	27.182	0.344	0.075	5.465	9.771	1.465	0.504	0.567	0.178	N60cs>25
328.5	77.5	62	6	0.078	5.606	34.074	34.264	1.000	0.078	5.656	10.118	1.455	1.455	0.546	0.171	N60cs>25
326	80	32	12	0.071	5.792	17.188	19.284	0.207	0.071	5.842	10.460	1.445	0.299	0.526	0.165	1.812

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-03** **1000 Long period**

ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.

DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)

DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.70** FT. (Below Finished Grade Cut or Fill Surface)

MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.100** Coefficient of Gravity

DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.5** Moment Magnitude Scale

FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)

ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.000</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake					Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)						
403.2	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	0.466	0.466	1.000	0.139	0.994	0.065	ABO. WAT.		
400.7	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	0.741	0.741	1.000	0.126	0.989	0.064	ABO. WAT.		
398.2	7.5	2	50	0.102	0.839	2.522	8.026	0.096	0.049	0.939	1.051	1.000	0.096	0.983	0.072	NL		
395.7	10	2	50	0.049	1.028	2.340	7.808	0.094	0.049	1.062	1.330	1.000	0.094	0.977	0.080	NL		
393.2	12.5	3	50	0.052	1.154	3.401	9.081	0.105	0.052	1.188	1.612	1.000	0.105	0.971	0.086	NL		
390.7	15	11	5	0.062	1.297	12.066	12.066	0.132	0.062	1.331	1.911	1.000	0.132	0.966	0.090	1.467		
388.2	17.5	17	5	0.066	1.457	18.038	18.038	0.192	0.066	1.491	2.227	1.000	0.192	0.960	0.093	2.065		
385.7	20	16	5	0.065	1.621	16.490	16.490	0.175	0.065	1.655	2.547	1.000	0.175	0.954	0.095	1.842		
383.2	22.5	17	5	0.066	1.785	17.097	17.097	0.182	0.066	1.819	2.867	1.000	0.182	0.948	0.097	1.876		
380.7	25	19	5	0.067	1.951	18.705	18.705	0.200	0.067	1.985	3.189	1.000	0.200	0.943	0.098	2.041		
378.2	27.5	17	5	0.066	2.117	16.434	16.434	0.175	0.066	2.151	3.511	0.997	0.174	0.937	0.099	1.758		
375.7	30	24	5	0.069	2.286	22.445	22.445	0.248	0.069	2.320	3.836	0.982	0.244	0.931	0.100	2.440		
373.2	32.5	13	5	0.063	2.451	11.741	11.741	0.129	0.063	2.485	4.157	0.969	0.125	0.911	0.099	1.263		
370.7	35	17	5	0.066	2.612	14.873	14.873	0.159	0.066	2.646	4.474	0.957	0.152	0.891	0.098	1.551		
368.2	37.5	19	5	0.067	2.778	16.119	16.119	0.172	0.067	2.812	4.796	0.945	0.163	0.870	0.096	1.698		
365.7	40	22	5	0.068	2.947	18.121	18.121	0.193	0.068	2.981	5.121	0.934	0.180	0.850	0.095	1.895		
363.2	42.5	33	5	0.072	3.122	26.409	26.409	0.323	0.072	3.156	5.452	0.924	0.298	0.830	0.093	N60cs>25		
360.7	45	20	5	0.067	3.296	15.577	15.577	0.166	0.067	3.330	5.782	0.914	0.152	0.810	0.091	1.670		
358.2	47.5	23	5	0.068	3.465	17.471	17.471	0.186	0.068	3.499	6.107	0.905	0.168	0.789	0.090	1.867		
355.7	50	25	5	0.069	3.636	18.539	18.539	0.198	0.069	3.670	6.434	0.896	0.177	0.769	0.088	2.011		
353.2	52.5	35	5	0.072	3.812	25.348	25.348	0.299	0.072	3.846	6.766	0.888	0.266	0.749	0.086	N60cs>25		
350.7	55	31	5	0.071	3.991	21.942	21.942	0.241	0.071	4.025	7.101	0.880	0.212	0.729	0.084	2.524		
348.2	57.5	29	5	0.071	4.169	19.425	19.425	0.208	0.071	4.203	7.435	0.872	0.181	0.708	0.081	2.235		
345.7	60	17	5	0.066	4.340	11.098	11.098	0.123	0.066	4.374	7.762	0.865	0.106	0.688	0.079	1.342		
343.2	62.5	28	5	0.070	4.510	17.829	17.829	0.190	0.070	4.544	8.088	0.859	0.163	0.668	0.077	2.117		
340.7	65	21	5	0.068	4.683	13.045	13.045	0.141	0.068	4.717	8.417	0.852	0.120	0.648	0.075	1.600		
338.2	67.5	32	5	0.071	4.857	19.402	19.402	0.208	0.071	4.891	8.747	0.846	0.176	0.627	0.073	2.411		
335.7	70	32	5	0.071	5.035	18.937	18.937	0.203	0.071	5.069	9.081	0.840	0.171	0.607	0.071	2.408		
333.2	72.5	38	5	0.073	5.215	21.957	21.957	0.241	0.073	5.249	9.417	0.834	0.201	0.587	0.068	2.956		
330.7	75	32	5	0.071	5.395	18.063	18.063	0.193	0.071	5.429	9.753	0.829	0.160	0.567	0.066	2.424		
328.2	77.5	41	5	0.074	5.576	22.618	22.618	0.251	0.074	5.610	10.090	0.823	0.207	0.546	0.064	3.234		
325.7	80	11	12	0.062	5.746	5.942	7.683	0.093	0.062	5.780	10.416	0.818	0.076	0.526	0.062	1.226		

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction



# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-03** **1000 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.70** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.190** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **5.6** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 2.112</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
403.2	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	0.466	0.466	2.112	0.294	0.994	0.123	ABO. WAT.
400.7	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	0.741	0.741	2.112	0.266	0.989	0.122	ABO. WAT.
398.2	7.5	2	50	0.102	0.839	2.522	8.026	0.096	0.049	0.939	1.051	2.112	0.203	0.983	0.136	NL
395.7	10	2	50	0.049	1.028	2.340	7.808	0.094	0.049	1.062	1.330	2.112	0.199	0.977	0.151	NL
393.2	12.5	3	50	0.052	1.154	3.401	9.081	0.105	0.052	1.188	1.612	2.112	0.222	0.971	0.163	NL
390.7	15	11	5	0.062	1.297	12.066	12.066	0.132	0.062	1.331	1.911	2.112	0.279	0.966	0.171	1.632
388.2	17.5	17	5	0.066	1.457	18.038	18.038	0.192	0.066	1.491	2.227	2.112	0.406	0.960	0.177	2.294
385.7	20	16	5	0.065	1.621	16.490	16.490	0.175	0.065	1.655	2.547	2.112	0.370	0.954	0.181	2.044
383.2	22.5	17	5	0.066	1.785	17.097	17.097	0.182	0.066	1.819	2.867	2.112	0.384	0.948	0.185	2.076
380.7	25	19	5	0.067	1.951	18.705	18.705	0.200	0.067	1.985	3.189	2.112	0.422	0.943	0.187	2.257
378.2	27.5	17	5	0.066	2.117	16.434	16.434	0.175	0.066	2.151	3.511	2.106	0.369	0.937	0.189	1.952
375.7	30	24	5	0.069	2.286	22.445	22.445	0.248	0.069	2.320	3.836	2.074	0.514	0.931	0.190	2.705
373.2	32.5	13	5	0.063	2.451	11.741	11.741	0.129	0.063	2.485	4.157	2.046	0.264	0.911	0.188	1.404
370.7	35	17	5	0.066	2.612	14.873	14.873	0.159	0.066	2.646	4.474	2.020	0.321	0.891	0.186	1.726
368.2	37.5	19	5	0.067	2.778	16.119	16.119	0.172	0.067	2.812	4.796	1.996	0.343	0.870	0.183	1.874
365.7	40	22	5	0.068	2.947	18.121	18.121	0.193	0.068	2.981	5.121	1.973	0.381	0.850	0.180	2.117
363.2	42.5	33	5	0.072	3.122	26.409	26.409	0.323	0.072	3.156	5.452	1.950	0.630	0.830	0.177	N60cs>25
360.7	45	20	5	0.067	3.296	15.577	15.577	0.166	0.067	3.330	5.782	1.930	0.320	0.810	0.174	1.839
358.2	47.5	23	5	0.068	3.465	17.471	17.471	0.186	0.068	3.499	6.107	1.911	0.355	0.789	0.170	2.088
355.7	50	25	5	0.069	3.636	18.539	18.539	0.198	0.069	3.670	6.434	1.892	0.375	0.769	0.166	2.259
353.2	52.5	35	5	0.072	3.812	25.348	25.348	0.299	0.072	3.846	6.766	1.875	0.561	0.749	0.163	N60cs>25
350.7	55	31	5	0.071	3.991	21.942	21.942	0.241	0.071	4.025	7.101	1.858	0.448	0.729	0.159	2.818
348.2	57.5	29	5	0.071	4.169	19.425	19.425	0.208	0.071	4.203	7.435	1.842	0.383	0.708	0.155	2.471
345.7	60	17	5	0.066	4.340	11.098	11.098	0.123	0.066	4.374	7.762	1.827	0.225	0.688	0.151	1.490
343.2	62.5	28	5	0.070	4.510	17.829	17.829	0.190	0.070	4.544	8.088	1.813	0.344	0.668	0.147	2.340
340.7	65	21	5	0.068	4.683	13.045	13.045	0.141	0.068	4.717	8.417	1.800	0.254	0.648	0.143	1.776
338.2	67.5	32	5	0.071	4.857	19.402	19.402	0.208	0.071	4.891	8.747	1.787	0.372	0.627	0.138	2.696
335.7	70	32	5	0.071	5.035	18.937	18.937	0.203	0.071	5.069	9.081	1.774	0.360	0.607	0.134	2.687
333.2	72.5	38	5	0.073	5.215	21.957	21.957	0.241	0.073	5.249	9.417	1.762	0.425	0.587	0.130	3.269
330.7	75	32	5	0.071	5.395	18.063	18.063	0.193	0.071	5.429	9.753	1.750	0.338	0.567	0.126	2.683
328.2	77.5	41	5	0.074	5.576	22.618	22.618	0.251	0.074	5.610	10.090	1.738	0.436	0.546	0.121	3.603
325.7	80	11	12	0.062	5.746	5.942	7.683	0.093	0.062	5.780	10.416	1.728	0.161	0.526	0.117	1.376

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-03** **2500 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.70** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.110** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.7** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 0.935</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
403.2	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	0.466	0.466	0.935	0.130	0.994	0.071	ABO. WAT.
400.7	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	0.741	0.741	0.935	0.118	0.989	0.071	ABO. WAT.
398.2	7.5	2	50	0.102	0.839	2.522	8.026	0.096	0.049	0.939	1.051	0.935	0.090	0.983	0.079	NL
395.7	10	2	50	0.049	1.028	2.340	7.808	0.094	0.049	1.062	1.330	0.935	0.088	0.977	0.087	NL
393.2	12.5	3	50	0.052	1.154	3.401	9.081	0.105	0.052	1.188	1.612	0.935	0.098	0.971	0.094	NL
390.7	15	11	5	0.062	1.297	12.066	12.066	0.132	0.062	1.331	1.911	0.935	0.123	0.966	0.099	1.242
388.2	17.5	17	5	0.066	1.457	18.038	18.038	0.192	0.066	1.491	2.227	0.935	0.180	0.960	0.103	1.748
385.7	20	16	5	0.065	1.621	16.490	16.490	0.175	0.065	1.655	2.547	0.935	0.164	0.954	0.105	1.562
383.2	22.5	17	5	0.066	1.785	17.097	17.097	0.182	0.066	1.819	2.867	0.935	0.170	0.948	0.107	1.589
380.7	25	19	5	0.067	1.951	18.705	18.705	0.200	0.067	1.985	3.189	0.935	0.187	0.943	0.108	1.731
378.2	27.5	17	5	0.066	2.117	16.434	16.434	0.175	0.066	2.151	3.511	0.932	0.163	0.937	0.109	1.495
375.7	30	24	5	0.069	2.286	22.445	22.445	0.248	0.069	2.320	3.836	0.918	0.228	0.931	0.110	2.073
373.2	32.5	13	5	0.063	2.451	11.741	11.741	0.129	0.063	2.485	4.157	0.906	0.117	0.911	0.109	1.073
370.7	35	17	5	0.066	2.612	14.873	14.873	0.159	0.066	2.646	4.474	0.894	0.142	0.891	0.108	1.315
368.2	37.5	19	5	0.067	2.778	16.119	16.119	0.172	0.067	2.812	4.796	0.884	0.152	0.870	0.106	1.434
365.7	40	22	5	0.068	2.947	18.121	18.121	0.193	0.068	2.981	5.121	0.873	0.168	0.850	0.104	1.615
363.2	42.5	33	5	0.072	3.122	26.409	26.409	0.323	0.072	3.156	5.452	0.863	0.279	0.830	0.103	N60cs>25
360.7	45	20	5	0.067	3.296	15.577	15.577	0.166	0.067	3.330	5.782	0.854	0.142	0.810	0.101	1.406
358.2	47.5	23	5	0.068	3.465	17.471	17.471	0.186	0.068	3.499	6.107	0.846	0.157	0.789	0.098	1.602
355.7	50	25	5	0.069	3.636	18.539	18.539	0.198	0.069	3.670	6.434	0.838	0.166	0.769	0.096	1.729
353.2	52.5	35	5	0.072	3.812	25.348	25.348	0.299	0.072	3.846	6.766	0.830	0.248	0.749	0.094	N60cs>25
350.7	55	31	5	0.071	3.991	21.942	21.942	0.241	0.071	4.025	7.101	0.822	0.198	0.729	0.092	2.152
348.2	57.5	29	5	0.071	4.169	19.425	19.425	0.208	0.071	4.203	7.435	0.815	0.170	0.708	0.090	1.889
345.7	60	17	5	0.066	4.340	11.098	11.098	0.123	0.066	4.374	7.762	0.809	0.100	0.688	0.087	1.149
343.2	62.5	28	5	0.070	4.510	17.829	17.829	0.190	0.070	4.544	8.088	0.803	0.153	0.668	0.085	1.800
340.7	65	21	5	0.068	4.683	13.045	13.045	0.141	0.068	4.717	8.417	0.797	0.112	0.648	0.083	1.349
338.2	67.5	32	5	0.071	4.857	19.402	19.402	0.208	0.071	4.891	8.747	0.791	0.165	0.627	0.080	2.063
335.7	70	32	5	0.071	5.035	18.937	18.937	0.203	0.071	5.069	9.081	0.785	0.159	0.607	0.078	2.038
333.2	72.5	38	5	0.073	5.215	21.957	21.957	0.241	0.073	5.249	9.417	0.780	0.188	0.587	0.075	2.507
330.7	75	32	5	0.071	5.395	18.063	18.063	0.193	0.071	5.429	9.753	0.775	0.150	0.567	0.073	2.055
328.2	77.5	41	5	0.074	5.576	22.618	22.618	0.251	0.074	5.610	10.090	0.770	0.193	0.546	0.070	2.757
325.7	80	11	12	0.062	5.746	5.942	7.683	0.093	0.062	5.780	10.416	0.765	0.071	0.526	0.068	1.044

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-03** **2500 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.70** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.270** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **6.0** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.770</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
403.2	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	0.466	0.466	1.770	0.246	0.994	0.174	ABO. WAT.
400.7	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	0.741	0.741	1.770	0.223	0.989	0.174	ABO. WAT.
398.2	7.5	2	50	0.102	0.839	2.522	8.026	0.096	0.049	0.939	1.051	1.770	0.170	0.983	0.193	NL
395.7	10	2	50	0.049	1.028	2.340	7.808	0.094	0.049	1.062	1.330	1.770	0.166	0.977	0.215	NL
393.2	12.5	3	50	0.052	1.154	3.401	9.081	0.105	0.052	1.188	1.612	1.770	0.186	0.971	0.231	NL
390.7	15	11	5	0.062	1.297	12.066	12.066	0.132	0.062	1.331	1.911	1.770	0.234	0.966	0.243	0.963
388.2	17.5	17	5	0.066	1.457	18.038	18.038	0.192	0.066	1.491	2.227	1.770	0.340	0.960	0.252	1.349
385.7	20	16	5	0.065	1.621	16.490	16.490	0.175	0.065	1.655	2.547	1.770	0.310	0.954	0.258	1.202
383.2	22.5	17	5	0.066	1.785	17.097	17.097	0.182	0.066	1.819	2.867	1.770	0.322	0.948	0.262	1.229
380.7	25	19	5	0.067	1.951	18.705	18.705	0.200	0.067	1.985	3.189	1.770	0.354	0.943	0.266	1.331
378.2	27.5	17	5	0.066	2.117	16.434	16.434	0.175	0.066	2.151	3.511	1.765	0.309	0.937	0.268	1.153
375.7	30	24	5	0.069	2.286	22.445	22.445	0.248	0.069	2.320	3.836	1.738	0.431	0.931	0.270	1.596
373.2	32.5	13	5	0.063	2.451	11.741	11.741	0.129	0.063	2.485	4.157	1.715	0.221	0.911	0.267	0.828
370.7	35	17	5	0.066	2.612	14.873	14.873	0.159	0.066	2.646	4.474	1.693	0.269	0.891	0.264	1.019
368.2	37.5	19	5	0.067	2.778	16.119	16.119	0.172	0.067	2.812	4.796	1.673	0.288	0.870	0.260	1.108
365.7	40	22	5	0.068	2.947	18.121	18.121	0.193	0.068	2.981	5.121	1.653	0.319	0.850	0.256	1.246
363.2	42.5	33	5	0.072	3.122	26.409	26.409	0.323	0.072	3.156	5.452	1.635	0.528	0.830	0.252	N60cs>25
360.7	45	20	5	0.067	3.296	15.577	15.577	0.166	0.067	3.330	5.782	1.617	0.268	0.810	0.247	1.085
358.2	47.5	23	5	0.068	3.465	17.471	17.471	0.186	0.068	3.499	6.107	1.601	0.298	0.789	0.242	1.231
355.7	50	25	5	0.069	3.636	18.539	18.539	0.198	0.069	3.670	6.434	1.586	0.314	0.769	0.237	1.325
353.2	52.5	35	5	0.072	3.812	25.348	25.348	0.299	0.072	3.846	6.766	1.571	0.470	0.749	0.231	N60cs>25
350.7	55	31	5	0.071	3.991	21.942	21.942	0.241	0.071	4.025	7.101	1.557	0.375	0.729	0.226	1.659
348.2	57.5	29	5	0.071	4.169	19.425	19.425	0.208	0.071	4.203	7.435	1.544	0.321	0.708	0.220	1.459
345.7	60	17	5	0.066	4.340	11.098	11.098	0.123	0.066	4.374	7.762	1.531	0.188	0.688	0.214	0.879
343.2	62.5	28	5	0.070	4.510	17.829	17.829	0.190	0.070	4.544	8.088	1.520	0.289	0.668	0.209	1.383
340.7	65	21	5	0.068	4.683	13.045	13.045	0.141	0.068	4.717	8.417	1.508	0.213	0.648	0.203	1.049
338.2	67.5	32	5	0.071	4.857	19.402	19.402	0.208	0.071	4.891	8.747	1.497	0.311	0.627	0.197	1.579
335.7	70	32	5	0.071	5.035	18.937	18.937	0.203	0.071	5.069	9.081	1.487	0.302	0.607	0.191	1.581
333.2	72.5	38	5	0.073	5.215	21.957	21.957	0.241	0.073	5.249	9.417	1.476	0.356	0.587	0.185	1.924
330.7	75	32	5	0.071	5.395	18.063	18.063	0.193	0.071	5.429	9.753	1.467	0.283	0.567	0.179	1.581
328.2	77.5	41	5	0.074	5.576	22.618	22.618	0.251	0.074	5.610	10.090	1.457	0.366	0.546	0.172	2.128
325.7	80	11	12	0.062	5.746	5.942	7.683	0.093	0.062	5.780	10.416	1.448	0.135	0.526	0.166	0.813

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-04 1000 Long period  
 ELEVATION OF BORING GROUND SURFACE ===== 405.40 FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 5.40 FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.100 Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 7.5 Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 0.00 FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.000</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
402.9	2.5	7	50	0.115	0.300	9.190	16.028	0.171	0.115	0.451	0.451	1.000	0.171	0.994	0.065	ABO. WAT.
400.4	5	2	50	0.102	0.571	2.701	8.241	0.098	0.102	0.722	0.722	1.000	0.098	0.989	0.064	ABO. WAT.
397.9	7.5	2	50	0.102	0.826	2.541	8.049	0.096	0.049	0.911	1.042	1.000	0.096	0.983	0.073	NL
395.4	10	6	35	0.057	1.025	7.031	13.437	0.145	0.057	1.044	1.331	1.000	0.145	0.977	0.081	1.790
392.9	12.5	4	50	0.054	1.164	4.515	10.418	0.117	0.054	1.183	1.626	1.000	0.117	0.971	0.087	NL
390.4	15	7	35	0.058	1.304	7.658	14.190	0.152	0.058	1.323	1.922	1.000	0.152	0.966	0.091	1.670
387.9	17.5	26	6	0.070	1.464	27.521	27.680	0.359	0.070	1.483	2.238	1.000	0.359	0.960	0.094	N60cs>25
385.4	20	14	6	0.064	1.632	14.380	14.477	0.155	0.064	1.651	2.562	1.000	0.155	0.954	0.096	1.615
382.9	22.5	6	35	0.057	1.783	6.038	12.246	0.133	0.057	1.802	2.869	1.000	0.133	0.948	0.098	1.357
380.4	25	18	6	0.066	1.937	17.785	17.898	0.191	0.066	1.956	3.179	1.000	0.191	0.943	0.100	1.910
377.9	27.5	16	6	0.065	2.101	15.526	15.629	0.166	0.065	2.120	3.499	1.000	0.166	0.937	0.101	1.644
375.4	30	19	6	0.067	2.266	17.847	17.960	0.191	0.067	2.285	3.820	0.985	0.188	0.931	0.101	1.861
372.9	32.5	26	6	0.070	2.437	23.550	23.690	0.268	0.070	2.456	4.147	0.971	0.260	0.911	0.100	2.600
370.4	35	18	6	0.066	2.607	15.763	15.867	0.169	0.066	2.626	4.473	0.958	0.162	0.891	0.099	1.636
367.9	37.5	11	6	0.062	2.767	9.351	9.425	0.108	0.062	2.786	4.789	0.947	0.102	0.870	0.097	1.052
365.4	40	19	6	0.067	2.928	15.701	15.804	0.168	0.067	2.947	5.106	0.936	0.157	0.850	0.096	1.635
362.9	42.5	19	6	0.067	3.096	15.269	15.370	0.164	0.067	3.115	5.430	0.926	0.152	0.830	0.094	1.617
360.4	45	12	6	0.063	3.259	9.399	9.473	0.109	0.063	3.278	5.749	0.917	0.100	0.810	0.092	1.087
357.9	47.5	24	6	0.069	3.424	18.340	18.456	0.197	0.069	3.443	6.070	0.908	0.179	0.789	0.090	1.989
355.4	50	20	6	0.067	3.594	14.917	15.017	0.160	0.067	3.613	6.396	0.899	0.144	0.769	0.088	1.636
352.9	52.5	17	6	0.066	3.760	12.397	12.485	0.136	0.066	3.779	6.718	0.891	0.121	0.749	0.087	1.391
350.4	55	25	6	0.069	3.929	17.834	17.947	0.191	0.069	3.948	7.043	0.883	0.169	0.729	0.085	1.988
347.9	57.5	34	6	0.072	4.105	22.998	23.136	0.259	0.072	4.124	7.375	0.875	0.227	0.708	0.082	2.768
345.4	60	20	6	0.067	4.279	13.176	13.268	0.143	0.067	4.298	7.705	0.868	0.124	0.688	0.080	1.550
342.9	62.5	29	6	0.071	4.452	18.622	18.739	0.200	0.071	4.471	8.034	0.861	0.172	0.668	0.078	2.205
340.4	65	18	6	0.066	4.623	11.277	11.360	0.125	0.066	4.642	8.361	0.855	0.107	0.648	0.076	1.408
337.9	67.5	36	6	0.073	4.797	22.009	22.142	0.244	0.073	4.816	8.691	0.849	0.207	0.627	0.074	2.797
335.4	70	19	6	0.067	4.972	11.340	11.423	0.126	0.067	4.991	9.022	0.843	0.106	0.607	0.071	1.493
332.9	72.5	8	6	0.059	5.130	4.675	4.727	0.070	0.059	5.149	9.336	0.837	0.059	0.587	0.069	0.855
330.4	75	27	6	0.070	5.291	15.447	15.549	0.166	0.070	5.310	9.653	0.832	0.138	0.567	0.067	2.060
327.9	77.5	42	6	0.074	5.471	23.479	23.619	0.267	0.074	5.490	9.989	0.827	0.221	0.546	0.065	3.400
325.4	80	12	12	0.063	5.642	6.566	8.327	0.099	0.063	5.661	10.316	0.822	0.081	0.526	0.062	1.306

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-04** **1000 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.40** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.40** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.190** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **5.6** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 2.112</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
402.9	2.5	7	50	0.115	0.300	9.190	16.028	0.171	0.115	0.451	0.451	2.112	0.361	0.994	0.123	ABO. WAT.
400.4	5	2	50	0.102	0.571	2.701	8.241	0.098	0.102	0.722	0.722	2.112	0.207	0.989	0.122	ABO. WAT.
397.9	7.5	2	50	0.102	0.826	2.541	8.049	0.096	0.049	0.911	1.042	2.112	0.203	0.983	0.139	NL
395.4	10	6	35	0.057	1.025	7.031	13.437	0.145	0.057	1.044	1.331	2.112	0.306	0.977	0.154	1.987
392.9	12.5	4	50	0.054	1.164	4.515	10.418	0.117	0.054	1.183	1.626	2.112	0.247	0.971	0.165	NL
390.4	15	7	35	0.058	1.304	7.658	14.190	0.152	0.058	1.323	1.922	2.112	0.321	0.966	0.173	1.855
387.9	17.5	26	6	0.070	1.464	27.521	27.680	0.359	0.070	1.483	2.238	2.112	0.758	0.960	0.179	N60cs>25
385.4	20	14	6	0.064	1.632	14.380	14.477	0.155	0.064	1.651	2.562	2.112	0.327	0.954	0.183	1.787
382.9	22.5	6	35	0.057	1.783	6.038	12.246	0.133	0.057	1.802	2.869	2.112	0.281	0.948	0.186	1.511
380.4	25	18	6	0.066	1.937	17.785	17.898	0.191	0.066	1.956	3.179	2.112	0.403	0.943	0.189	2.132
377.9	27.5	16	6	0.065	2.101	15.526	15.629	0.166	0.065	2.120	3.499	2.112	0.351	0.937	0.191	1.838
375.4	30	19	6	0.067	2.266	17.847	17.960	0.191	0.067	2.285	3.820	2.081	0.397	0.931	0.192	2.068
372.9	32.5	26	6	0.070	2.437	23.550	23.690	0.268	0.070	2.456	4.147	2.051	0.550	0.911	0.190	2.895
370.4	35	18	6	0.066	2.607	15.763	15.867	0.169	0.066	2.626	4.473	2.023	0.342	0.891	0.187	1.829
367.9	37.5	11	6	0.062	2.767	9.351	9.425	0.108	0.062	2.786	4.789	2.000	0.216	0.870	0.185	1.168
365.4	40	19	6	0.067	2.928	15.701	15.804	0.168	0.067	2.947	5.106	1.977	0.332	0.850	0.182	1.824
362.9	42.5	19	6	0.067	3.096	15.269	15.370	0.164	0.067	3.115	5.430	1.956	0.321	0.830	0.179	1.793
360.4	45	12	6	0.063	3.259	9.399	9.473	0.109	0.063	3.278	5.749	1.936	0.211	0.810	0.175	1.206
357.9	47.5	24	6	0.069	3.424	18.340	18.456	0.197	0.069	3.443	6.070	1.917	0.378	0.789	0.172	2.198
355.4	50	20	6	0.067	3.594	14.917	15.017	0.160	0.067	3.613	6.396	1.898	0.304	0.769	0.168	1.810
352.9	52.5	17	6	0.066	3.760	12.397	12.485	0.136	0.066	3.779	6.718	1.881	0.256	0.749	0.164	1.561
350.4	55	25	6	0.069	3.929	17.834	17.947	0.191	0.069	3.948	7.043	1.865	0.356	0.729	0.161	2.211
347.9	57.5	34	6	0.072	4.105	22.998	23.136	0.259	0.072	4.124	7.375	1.849	0.479	0.708	0.156	3.071
345.4	60	20	6	0.067	4.279	13.176	13.268	0.143	0.067	4.298	7.705	1.834	0.262	0.688	0.152	1.724
342.9	62.5	29	6	0.071	4.452	18.622	18.739	0.200	0.071	4.471	8.034	1.819	0.364	0.668	0.148	2.459
340.4	65	18	6	0.066	4.623	11.277	11.360	0.125	0.066	4.642	8.361	1.806	0.226	0.648	0.144	1.569
337.9	67.5	36	6	0.073	4.797	22.009	22.142	0.244	0.073	4.816	8.691	1.792	0.437	0.627	0.140	3.121
335.4	70	19	6	0.067	4.972	11.340	11.423	0.126	0.067	4.991	9.022	1.780	0.224	0.607	0.136	1.647
332.9	72.5	8	6	0.059	5.130	4.675	4.727	0.070	0.059	5.149	9.336	1.769	0.124	0.587	0.131	0.947
330.4	75	27	6	0.070	5.291	15.447	15.549	0.166	0.070	5.310	9.653	1.758	0.292	0.567	0.127	2.299
327.9	77.5	42	6	0.074	5.471	23.479	23.619	0.267	0.074	5.490	9.989	1.746	0.466	0.546	0.123	3.789
325.4	80	12	12	0.063	5.642	6.566	8.327	0.099	0.063	5.661	10.316	1.735	0.172	0.526	0.118	1.458

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-04** **2500 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.40** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.40** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.110** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.7** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)=</b> 1.00
Earthquake Magnitude Scaling Factor <b>(MSF)=</b> 0.935

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
402.9	2.5	7	50	0.115	0.300	9.190	16.028	0.171	0.115	0.451	0.451	0.935	0.160	0.994	0.071	ABO. WAT.	
400.4	5	2	50	0.102	0.571	2.701	8.241	0.098	0.102	0.722	0.722	0.935	0.092	0.989	0.071	ABO. WAT.	
397.9	7.5	2	50	0.102	0.826	2.541	8.049	0.096	0.049	0.911	1.042	0.935	0.090	0.983	0.080	NL	
395.4	10	6	35	0.057	1.025	7.031	13.437	0.145	0.057	1.044	1.331	0.935	0.136	0.977	0.089	1.528	
392.9	12.5	4	50	0.054	1.164	4.515	10.418	0.117	0.054	1.183	1.626	0.935	0.109	0.971	0.095	NL	
390.4	15	7	35	0.058	1.304	7.658	14.190	0.152	0.058	1.323	1.922	0.935	0.142	0.966	0.100	1.420	
387.9	17.5	26	6	0.070	1.464	27.521	27.680	0.359	0.070	1.483	2.238	0.935	0.336	0.960	0.104	N60cs>25	
385.4	20	14	6	0.064	1.632	14.380	14.477	0.155	0.064	1.651	2.562	0.935	0.145	0.954	0.106	1.368	
382.9	22.5	6	35	0.057	1.783	6.038	12.246	0.133	0.057	1.802	2.869	0.935	0.124	0.948	0.108	1.148	
380.4	25	18	6	0.066	1.937	17.785	17.898	0.191	0.066	1.956	3.179	0.935	0.179	0.943	0.110	1.627	
377.9	27.5	16	6	0.065	2.101	15.526	15.629	0.166	0.065	2.120	3.499	0.935	0.155	0.937	0.111	1.396	
375.4	30	19	6	0.067	2.266	17.847	17.960	0.191	0.067	2.285	3.820	0.921	0.176	0.931	0.111	1.586	
372.9	32.5	26	6	0.070	2.437	23.550	23.690	0.268	0.070	2.456	4.147	0.908	0.243	0.911	0.110	2.209	
370.4	35	18	6	0.066	2.607	15.763	15.867	0.169	0.066	2.626	4.473	0.896	0.151	0.891	0.109	1.385	
367.9	37.5	11	6	0.062	2.767	9.351	9.425	0.108	0.062	2.786	4.789	0.885	0.096	0.870	0.107	0.897	
365.4	40	19	6	0.067	2.928	15.701	15.804	0.168	0.067	2.947	5.106	0.875	0.147	0.850	0.105	1.400	
362.9	42.5	19	6	0.067	3.096	15.269	15.370	0.164	0.067	3.115	5.430	0.866	0.142	0.830	0.103	1.379	
360.4	45	12	6	0.063	3.259	9.399	9.473	0.109	0.063	3.278	5.749	0.857	0.093	0.810	0.102	0.912	
357.9	47.5	24	6	0.069	3.424	18.340	18.456	0.197	0.069	3.443	6.070	0.849	0.167	0.789	0.099	1.687	
355.4	50	20	6	0.067	3.594	14.917	15.017	0.160	0.067	3.613	6.396	0.840	0.134	0.769	0.097	1.381	
352.9	52.5	17	6	0.066	3.760	12.397	12.485	0.136	0.066	3.779	6.718	0.833	0.113	0.749	0.095	1.189	
350.4	55	25	6	0.069	3.929	17.834	17.947	0.191	0.069	3.948	7.043	0.826	0.158	0.729	0.093	1.699	
347.9	57.5	34	6	0.072	4.105	22.998	23.136	0.259	0.072	4.124	7.375	0.818	0.212	0.708	0.091	2.330	
345.4	60	20	6	0.067	4.279	13.176	13.268	0.143	0.067	4.298	7.705	0.812	0.116	0.688	0.088	1.318	
342.9	62.5	29	6	0.071	4.452	18.622	18.739	0.200	0.071	4.471	8.034	0.805	0.161	0.668	0.086	1.872	
340.4	65	18	6	0.066	4.623	11.277	11.360	0.125	0.066	4.642	8.361	0.799	0.100	0.648	0.083	1.205	
337.9	67.5	36	6	0.073	4.797	22.009	22.142	0.244	0.073	4.816	8.691	0.793	0.193	0.627	0.081	2.383	
335.4	70	19	6	0.067	4.972	11.340	11.423	0.126	0.067	4.991	9.022	0.788	0.099	0.607	0.078	1.269	
332.9	72.5	8	6	0.059	5.130	4.675	4.727	0.070	0.059	5.149	9.336	0.783	0.055	0.587	0.076	0.724	
330.4	75	27	6	0.070	5.291	15.447	15.549	0.166	0.070	5.310	9.653	0.778	0.129	0.567	0.074	1.743	
327.9	77.5	42	6	0.074	5.471	23.479	23.619	0.267	0.074	5.490	9.989	0.773	0.206	0.546	0.071	2.901	
325.4	80	12	12	0.063	5.642	6.566	8.327	0.099	0.063	5.661	10.316	0.768	0.076	0.526	0.069	1.101	

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-04 2500 Short period  
 ELEVATION OF BORING GROUND SURFACE ===== 405.40 FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 5.40 FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.270 Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 6.0 Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 0.00 FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.770</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
402.9	2.5	7	50	0.115	0.300	9.190	16.028	0.171	0.115	0.451	0.451	1.770	0.303	0.994	0.174	ABO. WAT.
400.4	5	2	50	0.102	0.571	2.701	8.241	0.098	0.102	0.722	0.722	1.770	0.173	0.989	0.174	ABO. WAT.
397.9	7.5	2	50	0.102	0.826	2.541	8.049	0.096	0.049	0.911	1.042	1.770	0.170	0.983	0.197	NL
395.4	10	6	35	0.057	1.025	7.031	13.437	0.145	0.057	1.044	1.331	1.770	0.257	0.977	0.219	1.174
392.9	12.5	4	50	0.054	1.164	4.515	10.418	0.117	0.054	1.183	1.626	1.770	0.207	0.971	0.234	NL
390.4	15	7	35	0.058	1.304	7.658	14.190	0.152	0.058	1.323	1.922	1.770	0.269	0.966	0.246	1.093
387.9	17.5	26	6	0.070	1.464	27.521	27.680	0.359	0.070	1.483	2.238	1.770	0.635	0.960	0.254	N60cs>25
385.4	20	14	6	0.064	1.632	14.380	14.477	0.155	0.064	1.651	2.562	1.770	0.274	0.954	0.260	1.054
382.9	22.5	6	35	0.057	1.783	6.038	12.246	0.133	0.057	1.802	2.869	1.770	0.235	0.948	0.265	0.887
380.4	25	18	6	0.066	1.937	17.785	17.898	0.191	0.066	1.956	3.179	1.770	0.338	0.943	0.269	1.257
377.9	27.5	16	6	0.065	2.101	15.526	15.629	0.166	0.065	2.120	3.499	1.770	0.294	0.937	0.271	1.085
375.4	30	19	6	0.067	2.266	17.847	17.960	0.191	0.067	2.285	3.820	1.744	0.333	0.931	0.273	1.220
372.9	32.5	26	6	0.070	2.437	23.550	23.690	0.268	0.070	2.456	4.147	1.719	0.461	0.911	0.270	1.707
370.4	35	18	6	0.066	2.607	15.763	15.867	0.169	0.066	2.626	4.473	1.696	0.287	0.891	0.266	1.079
367.9	37.5	11	6	0.062	2.767	9.351	9.425	0.108	0.062	2.786	4.789	1.676	0.181	0.870	0.262	0.691
365.4	40	19	6	0.067	2.928	15.701	15.804	0.168	0.067	2.947	5.106	1.657	0.278	0.850	0.258	1.078
362.9	42.5	19	6	0.067	3.096	15.269	15.370	0.164	0.067	3.115	5.430	1.639	0.269	0.830	0.254	1.059
360.4	45	12	6	0.063	3.259	9.399	9.473	0.109	0.063	3.278	5.749	1.622	0.177	0.810	0.249	0.711
357.9	47.5	24	6	0.069	3.424	18.340	18.456	0.197	0.069	3.443	6.070	1.606	0.316	0.789	0.244	1.295
355.4	50	20	6	0.067	3.594	14.917	15.017	0.160	0.067	3.613	6.396	1.591	0.255	0.769	0.239	1.067
352.9	52.5	17	6	0.066	3.760	12.397	12.485	0.136	0.066	3.779	6.718	1.577	0.214	0.749	0.234	0.915
350.4	55	25	6	0.069	3.929	17.834	17.947	0.191	0.069	3.948	7.043	1.563	0.299	0.729	0.228	1.311
347.9	57.5	34	6	0.072	4.105	22.998	23.136	0.259	0.072	4.124	7.375	1.549	0.401	0.708	0.222	1.806
345.4	60	20	6	0.067	4.279	13.176	13.268	0.143	0.067	4.298	7.705	1.537	0.220	0.688	0.216	1.019
342.9	62.5	29	6	0.071	4.452	18.622	18.739	0.200	0.071	4.471	8.034	1.525	0.305	0.668	0.211	1.445
340.4	65	18	6	0.066	4.623	11.277	11.360	0.125	0.066	4.642	8.361	1.513	0.189	0.648	0.205	0.922
337.9	67.5	36	6	0.073	4.797	22.009	22.142	0.244	0.073	4.816	8.691	1.502	0.366	0.627	0.199	1.839
335.4	70	19	6	0.067	4.972	11.340	11.423	0.126	0.067	4.991	9.022	1.491	0.188	0.607	0.193	0.974
332.9	72.5	8	6	0.059	5.130	4.675	4.727	0.070	0.059	5.149	9.336	1.482	0.104	0.587	0.187	0.556
330.4	75	27	6	0.070	5.291	15.447	15.549	0.166	0.070	5.310	9.653	1.473	0.245	0.567	0.181	1.354
327.9	77.5	42	6	0.074	5.471	23.479	23.619	0.267	0.074	5.490	9.989	1.463	0.391	0.546	0.174	2.247
325.4	80	12	12	0.063	5.642	6.566	8.327	0.099	0.063	5.661	10.316	1.454	0.144	0.526	0.168	0.857

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-05** **1000 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.70** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.100** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.5** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(Kα)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.000</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (Kσ)(Kα)(MSF)				
403.2	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	0.466	0.466	1.000	0.155	0.994	0.065	ABO. WAT.
400.7	5	4	50	0.109	0.578	5.403	11.484	0.126	0.109	0.744	0.744	1.000	0.126	0.989	0.064	ABO. WAT.
398.2	7.5	4	50	0.109	0.851	5.008	11.010	0.122	0.054	0.948	1.060	1.000	0.122	0.983	0.071	NL
395.7	10	3	50	0.052	1.052	3.470	9.164	0.106	0.052	1.081	1.349	1.000	0.106	0.977	0.079	NL
393.2	12.5	8	35	0.059	1.191	8.927	15.712	0.167	0.059	1.220	1.644	1.000	0.167	0.971	0.085	1.965
390.7	15	9	35	0.060	1.340	9.713	16.656	0.177	0.060	1.369	1.949	1.000	0.177	0.966	0.089	1.989
388.2	17.5	13	6	0.063	1.494	13.622	13.716	0.147	0.063	1.523	2.259	1.000	0.147	0.960	0.093	1.581
385.7	20	13	6	0.063	1.652	13.272	13.364	0.144	0.063	1.681	2.573	1.000	0.144	0.954	0.095	1.516
383.2	22.5	24	6	0.069	1.817	23.923	24.065	0.275	0.069	1.846	2.894	1.000	0.275	0.948	0.097	2.835
380.7	25	19	6	0.067	1.987	18.535	18.652	0.199	0.067	2.016	3.220	1.000	0.199	0.943	0.098	2.031
378.2	27.5	24	6	0.069	2.157	22.985	23.123	0.259	0.069	2.186	3.546	0.994	0.257	0.937	0.099	2.596
375.7	30	14	6	0.064	2.323	22.988	13.079	0.141	0.064	2.352	3.868	0.979	0.138	0.931	0.100	1.380
373.2	32.5	20	6	0.067	2.487	17.933	18.047	0.192	0.067	2.516	4.188	0.966	0.185	0.911	0.099	1.869
370.7	35	17	6	0.066	2.653	14.758	14.857	0.159	0.066	2.682	4.510	0.954	0.152	0.891	0.097	1.567
368.2	37.5	23	6	0.068	2.821	19.363	19.484	0.209	0.068	2.850	4.834	0.943	0.197	0.870	0.096	2.052
365.7	40	23	6	0.068	2.991	18.805	18.923	0.202	0.068	3.020	5.160	0.932	0.188	0.850	0.094	2.000
363.2	42.5	14	4	0.064	3.156	11.143	11.143	0.123	0.064	3.185	5.481	0.922	0.113	0.830	0.093	1.215
360.7	45	19	4	0.067	3.320	14.745	14.745	0.158	0.067	3.349	5.801	0.913	0.144	0.810	0.091	1.582
358.2	47.5	13	4	0.063	3.483	9.850	9.850	0.112	0.063	3.512	6.120	0.904	0.101	0.789	0.089	1.135
355.7	50	20	12	0.067	3.646	14.811	16.832	0.179	0.067	3.675	6.439	0.896	0.160	0.769	0.088	1.818
353.2	52.5	24	6	0.069	3.816	17.372	17.483	0.186	0.069	3.845	6.765	0.888	0.165	0.749	0.086	1.919
350.7	55	25	6	0.069	3.989	17.699	17.812	0.190	0.069	4.018	7.094	0.880	0.167	0.729	0.084	1.988
348.2	57.5	31	6	0.071	4.164	20.780	20.907	0.227	0.071	4.193	7.425	0.872	0.198	0.708	0.081	2.444
345.7	60	32	6	0.071	4.342	20.884	21.012	0.228	0.071	4.371	7.759	0.865	0.197	0.688	0.079	2.494
343.2	62.5	54	6	0.076	4.526	34.306	34.497	1.000	0.076	4.555	8.099	0.858	0.858	0.668	0.077	N60cs>25
340.7	65	27	6	0.070	4.709	16.711	16.819	0.179	0.070	4.738	8.438	0.851	0.152	0.648	0.075	2.027
338.2	67.5	38	6	0.073	4.888	22.942	23.079	0.258	0.073	4.917	8.773	0.845	0.218	0.627	0.073	2.986
335.7	70	34	6	0.072	5.069	20.029	20.153	0.217	0.072	5.098	9.110	0.839	0.182	0.607	0.071	2.563
333.2	72.5	62	6	0.078	5.257	35.628	35.825	1.000	0.078	5.286	9.454	0.833	0.833	0.587	0.068	N60cs>25
330.7	75	20	6	0.067	5.438	11.227	11.309	0.125	0.067	5.467	9.791	0.827	0.103	0.567	0.066	1.561
328.2	77.5	41	6	0.074	5.614	22.511	22.646	0.252	0.074	5.643	10.123	0.822	0.207	0.546	0.064	3.234
325.7	80	16	12	0.065	5.788	8.598	10.423	0.117	0.065	5.817	10.453	0.817	0.096	0.526	0.061	1.574

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction



# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-05** **1000 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.70** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.190** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **5.6** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 2.112</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
403.2	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	0.466	0.466	2.112	0.327	0.994	0.123	ABO. WAT.
400.7	5	4	50	0.109	0.578	5.403	11.484	0.126	0.109	0.744	0.744	2.112	0.266	0.989	0.122	ABO. WAT.
398.2	7.5	4	50	0.109	0.851	5.008	11.010	0.122	0.054	0.948	1.060	2.112	0.258	0.983	0.136	NL
395.7	10	3	50	0.052	1.052	3.470	9.164	0.106	0.052	1.081	1.349	2.112	0.224	0.977	0.151	NL
393.2	12.5	8	35	0.059	1.191	8.927	15.712	0.167	0.059	1.220	1.644	2.112	0.353	0.971	0.162	2.179
390.7	15	9	35	0.060	1.340	9.713	16.656	0.177	0.060	1.369	1.949	2.112	0.374	0.966	0.170	2.200
388.2	17.5	13	6	0.063	1.494	13.622	13.716	0.147	0.063	1.523	2.259	2.112	0.310	0.960	0.176	1.761
385.7	20	13	6	0.063	1.652	13.272	13.364	0.144	0.063	1.681	2.573	2.112	0.304	0.954	0.180	1.689
383.2	22.5	24	6	0.069	1.817	23.923	24.065	0.275	0.069	1.846	2.894	2.112	0.581	0.948	0.184	3.158
380.7	25	19	6	0.067	1.987	18.535	18.652	0.199	0.067	2.016	3.220	2.112	0.420	0.943	0.186	2.258
378.2	27.5	24	6	0.069	2.157	22.985	23.123	0.259	0.069	2.186	3.546	2.099	0.544	0.937	0.188	2.894
375.7	30	14	6	0.064	2.323	12.988	13.079	0.141	0.064	2.352	3.868	2.069	0.292	0.931	0.189	1.545
373.2	32.5	20	6	0.067	2.487	17.933	18.047	0.192	0.067	2.516	4.188	2.041	0.392	0.911	0.187	2.096
370.7	35	17	6	0.066	2.653	14.758	14.857	0.159	0.066	2.682	4.510	2.015	0.320	0.891	0.185	1.730
368.2	37.5	23	6	0.068	2.821	19.363	19.484	0.209	0.068	2.850	4.834	1.991	0.416	0.870	0.182	2.286
365.7	40	23	6	0.068	2.991	18.805	18.923	0.202	0.068	3.020	5.160	1.968	0.398	0.850	0.179	2.223
363.2	42.5	14	4	0.064	3.156	11.143	11.143	0.123	0.064	3.185	5.481	1.947	0.239	0.830	0.176	1.358
360.7	45	19	4	0.067	3.320	14.745	14.745	0.158	0.067	3.349	5.801	1.927	0.304	0.810	0.173	1.757
358.2	47.5	13	4	0.063	3.483	9.850	9.850	0.112	0.063	3.512	6.120	1.909	0.214	0.789	0.170	1.259
355.7	50	20	12	0.067	3.646	14.811	16.832	0.179	0.067	3.675	6.439	1.892	0.339	0.769	0.166	2.042
353.2	52.5	24	6	0.069	3.816	17.372	17.483	0.186	0.069	3.845	6.765	1.875	0.349	0.749	0.163	2.141
350.7	55	25	6	0.069	3.989	17.699	17.812	0.190	0.069	4.018	7.094	1.858	0.353	0.729	0.159	2.220
348.2	57.5	31	6	0.071	4.164	20.780	20.907	0.227	0.071	4.193	7.425	1.843	0.418	0.708	0.155	2.697
345.7	60	32	6	0.071	4.342	20.884	21.012	0.228	0.071	4.371	7.759	1.827	0.417	0.688	0.151	2.762
343.2	62.5	54	6	0.076	4.526	34.306	34.497	1.000	0.076	4.555	8.099	1.812	1.812	0.668	0.147	N60cs>25
340.7	65	27	6	0.070	4.709	16.711	16.819	0.179	0.070	4.738	8.438	1.798	0.322	0.648	0.143	2.252
338.2	67.5	38	6	0.073	4.888	22.942	23.079	0.258	0.073	4.917	8.773	1.785	0.461	0.627	0.138	3.341
335.7	70	34	6	0.072	5.069	20.029	20.153	0.217	0.072	5.098	9.110	1.772	0.385	0.607	0.134	2.873
333.2	72.5	62	6	0.078	5.257	35.628	35.825	1.000	0.078	5.286	9.454	1.759	1.759	0.587	0.130	N60cs>25
330.7	75	20	6	0.067	5.438	11.227	11.309	0.125	0.067	5.467	9.791	1.747	0.218	0.567	0.125	1.744
328.2	77.5	41	6	0.074	5.614	22.511	22.646	0.252	0.074	5.643	10.123	1.736	0.437	0.546	0.121	3.612
325.7	80	16	12	0.065	5.788	8.598	10.423	0.117	0.065	5.817	10.453	1.726	0.202	0.526	0.117	1.726

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-05** **2500 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.70** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.110** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.7** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 0.935</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> )60	Fines Content Corrected (N <sub>1</sub> )60cs	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
403.2	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	0.466	0.466	0.935	0.145	0.994	0.071	ABO. WAT.	
400.7	5	4	50	0.109	0.578	5.403	11.484	0.126	0.109	0.744	0.744	0.935	0.118	0.989	0.071	ABO. WAT.	
398.2	7.5	4	50	0.109	0.851	5.008	11.010	0.122	0.054	0.948	1.060	0.935	0.114	0.983	0.079	NL	
395.7	10	3	50	0.052	1.052	3.470	9.164	0.106	0.052	1.081	1.349	0.935	0.099	0.977	0.087	NL	
393.2	12.5	8	35	0.059	1.191	8.927	15.712	0.167	0.059	1.220	1.644	0.935	0.156	0.971	0.094	1.660	
390.7	15	9	35	0.060	1.340	9.713	16.656	0.177	0.060	1.369	1.949	0.935	0.165	0.966	0.098	1.684	
388.2	17.5	13	6	0.063	1.494	13.622	13.716	0.147	0.063	1.523	2.259	0.935	0.137	0.960	0.102	1.343	
385.7	20	13	6	0.063	1.652	13.272	13.364	0.144	0.063	1.681	2.573	0.935	0.135	0.954	0.104	1.298	
383.2	22.5	24	6	0.069	1.817	23.923	24.065	0.275	0.069	1.846	2.894	0.935	0.257	0.948	0.106	2.425	
380.7	25	19	6	0.067	1.987	18.535	18.652	0.199	0.067	2.016	3.220	0.935	0.186	0.943	0.108	1.722	
378.2	27.5	24	6	0.069	2.157	22.985	23.123	0.259	0.069	2.186	3.546	0.929	0.241	0.937	0.109	2.211	
375.7	30	14	6	0.064	2.323	12.988	13.079	0.141	0.064	2.352	3.868	0.916	0.129	0.931	0.109	1.183	
373.2	32.5	20	6	0.067	2.487	17.933	18.047	0.192	0.067	2.516	4.188	0.904	0.174	0.911	0.108	1.611	
370.7	35	17	6	0.066	2.653	14.758	14.857	0.159	0.066	2.682	4.510	0.892	0.142	0.891	0.107	1.327	
368.2	37.5	23	6	0.068	2.821	19.363	19.484	0.209	0.068	2.850	4.834	0.881	0.184	0.870	0.106	1.736	
365.7	40	23	6	0.068	2.991	18.805	18.923	0.202	0.068	3.020	5.160	0.871	0.176	0.850	0.104	1.692	
363.2	42.5	14	4	0.064	3.156	11.143	11.143	0.123	0.064	3.185	5.481	0.862	0.106	0.830	0.102	1.039	
360.7	45	19	4	0.067	3.320	14.745	14.745	0.158	0.067	3.349	5.801	0.853	0.135	0.810	0.100	1.350	
358.2	47.5	13	4	0.063	3.483	9.850	9.850	0.112	0.063	3.512	6.120	0.845	0.095	0.789	0.098	0.969	
355.7	50	20	12	0.067	3.646	14.811	16.832	0.179	0.067	3.675	6.439	0.838	0.150	0.769	0.096	1.563	
353.2	52.5	24	6	0.069	3.816	17.372	17.483	0.186	0.069	3.845	6.765	0.830	0.154	0.749	0.094	1.638	
350.7	55	25	6	0.069	3.989	17.699	17.812	0.190	0.069	4.018	7.094	0.823	0.156	0.729	0.092	1.696	
348.2	57.5	31	6	0.071	4.164	20.780	20.907	0.227	0.071	4.193	7.425	0.816	0.185	0.708	0.090	2.056	
345.7	60	32	6	0.071	4.342	20.884	21.012	0.228	0.071	4.371	7.759	0.809	0.184	0.688	0.087	2.115	
343.2	62.5	54	6	0.076	4.526	34.306	34.497	1.000	0.076	4.555	8.099	0.802	0.802	0.668	0.085	N60cs>25	
340.7	65	27	6	0.070	4.709	16.711	16.819	0.179	0.070	4.738	8.438	0.796	0.142	0.648	0.083	1.711	
338.2	67.5	38	6	0.073	4.888	22.942	23.079	0.258	0.073	4.917	8.773	0.790	0.204	0.627	0.080	2.550	
335.7	70	34	6	0.072	5.069	20.029	20.153	0.217	0.072	5.098	9.110	0.785	0.170	0.607	0.078	2.179	
333.2	72.5	62	6	0.078	5.257	35.628	35.825	1.000	0.078	5.286	9.454	0.779	0.779	0.587	0.075	N60cs>25	
330.7	75	20	6	0.067	5.438	11.227	11.309	0.125	0.067	5.467	9.791	0.774	0.097	0.567	0.073	1.329	
328.2	77.5	41	6	0.074	5.614	22.511	22.646	0.252	0.074	5.643	10.123	0.769	0.194	0.546	0.070	2.771	
325.7	80	16	12	0.065	5.788	8.598	10.423	0.117	0.065	5.817	10.453	0.764	0.089	0.526	0.068	1.309	

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-05** **2500 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.70** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.270** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **6.0** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.770</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> )60	Fines Content Corrected (N <sub>1</sub> )60cs	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
403.2	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	0.466	0.466	1.770	0.274	0.994	0.174	ABO. WAT.
400.7	5	4	50	0.109	0.578	5.403	11.484	0.126	0.109	0.744	0.744	1.770	0.223	0.989	0.174	ABO. WAT.
398.2	7.5	4	50	0.109	0.851	5.008	11.010	0.122	0.054	0.948	1.060	1.770	0.216	0.983	0.193	NL
395.7	10	3	50	0.052	1.052	3.470	9.164	0.106	0.052	1.081	1.349	1.770	0.188	0.977	0.214	NL
393.2	12.5	8	35	0.059	1.191	8.927	15.712	0.167	0.059	1.220	1.644	1.770	0.296	0.971	0.230	1.287
390.7	15	9	35	0.060	1.340	9.713	16.656	0.177	0.060	1.369	1.949	1.770	0.313	0.966	0.241	1.299
388.2	17.5	13	6	0.063	1.494	13.622	13.716	0.147	0.063	1.523	2.259	1.770	0.260	0.960	0.250	1.040
385.7	20	13	6	0.063	1.652	13.272	13.364	0.144	0.063	1.681	2.573	1.770	0.255	0.954	0.256	0.996
383.2	22.5	24	6	0.069	1.817	23.923	24.065	0.275	0.069	1.846	2.894	1.770	0.487	0.948	0.261	1.866
380.7	25	19	6	0.067	1.987	18.535	18.652	0.199	0.067	2.016	3.220	1.770	0.352	0.943	0.264	1.333
378.2	27.5	24	6	0.069	2.157	22.985	23.123	0.259	0.069	2.186	3.546	1.759	0.456	0.937	0.267	1.708
375.7	30	14	6	0.064	2.323	12.988	13.079	0.141	0.064	2.352	3.868	1.734	0.244	0.931	0.269	0.907
373.2	32.5	20	6	0.067	2.487	17.933	18.047	0.192	0.067	2.516	4.188	1.710	0.328	0.911	0.266	1.233
370.7	35	17	6	0.066	2.653	14.758	14.857	0.159	0.066	2.682	4.510	1.689	0.269	0.891	0.263	1.023
368.2	37.5	23	6	0.068	2.821	19.363	19.484	0.209	0.068	2.850	4.834	1.668	0.349	0.870	0.259	1.347
365.7	40	23	6	0.068	2.991	18.805	18.923	0.202	0.068	3.020	5.160	1.649	0.333	0.850	0.255	1.306
363.2	42.5	14	4	0.064	3.156	11.143	11.143	0.123	0.064	3.185	5.481	1.632	0.201	0.830	0.251	0.801
360.7	45	19	4	0.067	3.320	14.745	14.745	0.158	0.067	3.349	5.801	1.615	0.255	0.810	0.246	1.037
358.2	47.5	13	4	0.063	3.483	9.850	9.850	0.112	0.063	3.512	6.120	1.600	0.179	0.789	0.241	0.743
355.7	50	20	12	0.067	3.646	14.811	16.832	0.179	0.067	3.675	6.439	1.586	0.284	0.769	0.236	1.203
353.2	52.5	24	6	0.069	3.816	17.372	17.483	0.186	0.069	3.845	6.765	1.571	0.292	0.749	0.231	1.264
350.7	55	25	6	0.069	3.989	17.699	17.812	0.190	0.069	4.018	7.094	1.558	0.296	0.729	0.226	1.310
348.2	57.5	31	6	0.071	4.164	20.780	20.907	0.227	0.071	4.193	7.425	1.544	0.350	0.708	0.220	1.591
345.7	60	32	6	0.071	4.342	20.884	21.012	0.228	0.071	4.371	7.759	1.532	0.349	0.688	0.214	1.631
343.2	62.5	54	6	0.076	4.526	34.306	34.497	1.000	0.076	4.555	8.099	1.519	1.519	0.668	0.208	N60cs>25
340.7	65	27	6	0.070	4.709	16.711	16.819	0.179	0.070	4.738	8.438	1.507	0.270	0.648	0.203	1.330
338.2	67.5	38	6	0.073	4.888	22.942	23.079	0.258	0.073	4.917	8.773	1.496	0.386	0.627	0.196	1.969
335.7	70	34	6	0.072	5.069	20.029	20.153	0.217	0.072	5.098	9.110	1.485	0.322	0.607	0.190	1.695
333.2	72.5	62	6	0.078	5.257	35.628	35.825	1.000	0.078	5.286	9.454	1.474	1.474	0.587	0.184	N60cs>25
330.7	75	20	6	0.067	5.438	11.227	11.309	0.125	0.067	5.467	9.791	1.465	0.183	0.567	0.178	1.028
328.2	77.5	41	6	0.074	5.614	22.511	22.646	0.252	0.074	5.643	10.123	1.455	0.367	0.546	0.172	2.134
325.7	80	16	12	0.065	5.788	8.598	10.423	0.117	0.065	5.817	10.453	1.446	0.169	0.526	0.166	1.018

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-06** **1000 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.80** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.80** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.100** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.5** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.000</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
403.3	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	0.472	0.472	1.000	0.155	0.994	0.065	ABO. WAT.	
400.8	5	7	50	0.115	0.585	9.455	16.346	0.174	0.115	0.757	0.757	1.000	0.174	0.989	0.064	ABO. WAT.	
398.3	7.5	4	50	0.109	0.865	4.967	10.960	0.122	0.054	0.968	1.074	1.000	0.122	0.983	0.071	NL	
395.8	10	5	50	0.055	1.070	5.734	11.881	0.130	0.055	1.104	1.366	1.000	0.130	0.977	0.079	NL	
393.3	12.5	6	20	0.057	1.210	6.643	10.785	0.120	0.057	1.244	1.662	1.000	0.120	0.971	0.084	1.429	
390.8	15	7	20	0.058	1.354	7.515	11.727	0.129	0.058	1.388	1.962	1.000	0.129	0.966	0.089	1.449	
388.3	17.5	11	35	0.062	1.504	11.488	18.786	0.201	0.062	1.538	2.268	1.000	0.201	0.960	0.092	2.185	
385.8	20	15	12	0.065	1.663	15.263	17.298	0.184	0.065	1.697	2.583	1.000	0.184	0.954	0.094	1.957	
383.3	22.5	7	12	0.058	1.817	6.978	8.752	0.102	0.058	1.851	2.893	1.000	0.102	0.948	0.096	1.063	
380.8	25	18	5	0.066	1.972	17.626	17.626	0.188	0.066	2.006	3.204	1.000	0.188	0.943	0.098	1.918	
378.3	27.5	16	5	0.065	2.136	15.399	15.399	0.164	0.065	2.170	3.524	0.995	0.163	0.937	0.099	1.646	
375.8	30	29	5	0.071	2.306	27.003	27.003	0.338	0.071	2.340	3.850	0.980	0.331	0.931	0.100	N60cs>25	
373.3	32.5	33	5	0.072	2.485	29.601	29.601	0.442	0.072	2.519	4.185	0.966	0.427	0.911	0.098	N60cs>25	
370.8	35	20	5	0.067	2.659	17.343	17.343	0.185	0.067	2.693	4.515	0.953	0.176	0.891	0.097	1.814	
368.3	37.5	21	5	0.068	2.828	17.657	17.657	0.188	0.068	2.862	4.840	0.942	0.177	0.870	0.096	1.844	
365.8	40	11	5	0.062	2.991	8.994	8.994	0.104	0.062	3.025	5.159	0.931	0.097	0.850	0.094	1.032	
363.3	42.5	23	5	0.068	3.154	18.312	18.312	0.195	0.068	3.188	5.478	0.922	0.180	0.830	0.093	1.935	
360.8	45	17	5	0.066	3.322	13.189	13.189	0.142	0.066	3.356	5.802	0.912	0.130	0.810	0.091	1.429	
358.3	47.5	23	5	0.068	3.490	17.409	17.409	0.185	0.068	3.524	6.126	0.903	0.167	0.789	0.089	1.876	
355.8	50	20	5	0.067	3.659	14.784	14.784	0.158	0.067	3.693	6.451	0.895	0.141	0.769	0.087	1.621	
353.3	52.5	25	5	0.069	3.829	18.065	18.065	0.193	0.069	3.863	6.777	0.887	0.171	0.749	0.085	2.012	
350.8	55	39	5	0.073	4.007	26.783	26.783	0.332	0.073	4.041	7.111	0.879	0.292	0.729	0.083	N60cs>25	
348.3	57.5	26	5	0.070	4.186	17.370	17.370	0.185	0.070	4.220	7.446	0.871	0.161	0.708	0.081	1.988	
345.8	60	31	5	0.071	4.362	20.172	20.172	0.218	0.071	4.396	7.778	0.864	0.188	0.688	0.079	2.380	
343.3	62.5	38	5	0.073	4.542	24.085	24.085	0.275	0.073	4.576	8.114	0.857	0.236	0.668	0.077	3.065	
340.8	65	39	5	0.073	4.725	24.084	24.084	0.275	0.073	4.759	8.453	0.851	0.234	0.648	0.075	3.120	
338.3	67.5	33	5	0.072	4.906	19.874	19.874	0.214	0.072	4.940	8.790	0.844	0.181	0.627	0.073	2.479	
335.8	70	38	12	0.073	5.087	22.332	24.591	0.284	0.073	5.121	9.127	0.838	0.238	0.607	0.070	3.400	
333.3	72.5	52	5	0.076	5.273	29.819	29.819	0.455	0.076	5.307	9.469	0.832	0.379	0.587	0.068	N60cs>25	
330.8	75	43	5	0.074	5.461	24.068	24.068	0.275	0.074	5.495	9.813	0.827	0.227	0.567	0.066	3.439	
328.3	77.5	24	12	0.069	5.640	13.134	15.102	0.161	0.069	5.674	10.148	0.821	0.132	0.546	0.063	2.095	
325.8	80	16	12	0.065	5.808	8.577	10.401	0.117	0.065	5.842	10.472	0.816	0.095	0.526	0.061	1.557	

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-06** **1000 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.80** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.80** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.190** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **5.6** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 2.112</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
403.3	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	0.472	0.472	2.112	0.327	0.994	0.123	ABO. WAT.	
400.8	5	7	50	0.115	0.585	9.455	16.346	0.174	0.115	0.757	0.757	2.112	0.367	0.989	0.122	ABO. WAT.	
398.3	7.5	4	50	0.109	0.865	4.967	10.960	0.122	0.054	0.968	1.074	2.112	0.258	0.983	0.135	NL	
395.8	10	5	50	0.055	1.070	5.734	11.881	0.130	0.055	1.104	1.366	2.112	0.275	0.977	0.149	NL	
393.3	12.5	6	20	0.057	1.210	6.643	10.785	0.120	0.057	1.244	1.662	2.112	0.253	0.971	0.160	1.581	
390.8	15	7	20	0.058	1.354	7.515	11.727	0.129	0.058	1.388	1.962	2.112	0.272	0.966	0.169	1.609	
388.3	17.5	11	35	0.062	1.504	11.488	18.786	0.201	0.062	1.538	2.268	2.112	0.425	0.960	0.175	2.429	
385.8	20	15	12	0.065	1.663	15.263	17.298	0.184	0.065	1.697	2.583	2.112	0.389	0.954	0.179	2.173	
383.3	22.5	7	12	0.058	1.817	6.978	8.752	0.102	0.058	1.851	2.893	2.112	0.215	0.948	0.183	1.175	
380.8	25	18	5	0.066	1.972	17.626	17.626	0.188	0.066	2.006	3.204	2.112	0.397	0.943	0.186	2.134	
378.3	27.5	16	5	0.065	2.136	15.399	15.399	0.164	0.065	2.170	3.524	2.102	0.345	0.937	0.188	1.835	
375.8	30	29	5	0.071	2.306	27.003	27.003	0.338	0.071	2.340	3.850	2.071	0.700	0.931	0.189	N60cs>25	
373.3	32.5	33	5	0.072	2.485	29.601	29.601	0.442	0.072	2.519	4.185	2.040	0.902	0.911	0.187	N60cs>25	
370.8	35	20	5	0.067	2.659	17.343	17.343	0.185	0.067	2.693	4.515	2.013	0.372	0.891	0.184	2.022	
368.3	37.5	21	5	0.068	2.828	17.657	17.657	0.188	0.068	2.862	4.840	1.989	0.374	0.870	0.182	2.055	
365.8	40	11	5	0.062	2.991	8.994	8.994	0.104	0.062	3.025	5.159	1.967	0.205	0.850	0.179	1.145	
363.3	42.5	23	5	0.068	3.154	18.312	18.312	0.195	0.068	3.188	5.478	1.947	0.380	0.830	0.176	2.159	
360.8	45	17	5	0.066	3.322	13.189	13.189	0.142	0.066	3.356	5.802	1.927	0.274	0.810	0.173	1.584	
358.3	47.5	23	5	0.068	3.490	17.409	17.409	0.185	0.068	3.524	6.126	1.908	0.353	0.789	0.169	2.089	
355.8	50	20	5	0.067	3.659	14.784	14.784	0.158	0.067	3.693	6.451	1.890	0.299	0.769	0.166	1.801	
353.3	52.5	25	5	0.069	3.829	18.065	18.065	0.193	0.069	3.863	6.777	1.873	0.361	0.749	0.162	2.228	
350.8	55	39	5	0.073	4.007	26.783	26.783	0.332	0.073	4.041	7.111	1.856	0.616	0.729	0.158	N60cs>25	
348.3	57.5	26	5	0.070	4.186	17.370	17.370	0.185	0.070	4.220	7.446	1.840	0.340	0.708	0.154	2.208	
345.8	60	31	5	0.071	4.362	20.172	20.172	0.218	0.071	4.396	7.778	1.825	0.398	0.688	0.150	2.653	
343.3	62.5	38	5	0.073	4.542	24.085	24.085	0.275	0.073	4.576	8.114	1.811	0.498	0.668	0.146	3.411	
340.8	65	39	5	0.073	4.725	24.084	24.084	0.275	0.073	4.759	8.453	1.797	0.494	0.648	0.142	3.479	
338.3	67.5	33	5	0.072	4.906	19.874	19.874	0.214	0.072	4.940	8.790	1.783	0.382	0.627	0.138	2.768	
335.8	70	38	12	0.073	5.087	22.332	24.591	0.284	0.073	5.121	9.127	1.770	0.503	0.607	0.134	3.754	
333.3	72.5	52	5	0.076	5.273	29.819	29.819	0.455	0.076	5.307	9.469	1.758	0.800	0.587	0.129	N60cs>25	
330.8	75	43	5	0.074	5.461	24.068	24.068	0.275	0.074	5.495	9.813	1.746	0.480	0.567	0.125	3.840	
328.3	77.5	24	12	0.069	5.640	13.134	15.102	0.161	0.069	5.674	10.148	1.735	0.279	0.546	0.121	2.306	
325.8	80	16	12	0.065	5.808	8.577	10.401	0.117	0.065	5.842	10.472	1.724	0.202	0.526	0.116	1.741	

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-06** **2500 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.80** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.80** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.120** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.7** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 0.935</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
403.3	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	0.472	0.472	0.935	0.145	0.994	0.078	ABO. WAT.	
400.8	5	7	50	0.115	0.585	9.455	16.346	0.174	0.115	0.757	0.757	0.935	0.163	0.989	0.077	ABO. WAT.	
398.3	7.5	4	50	0.109	0.865	4.967	10.960	0.122	0.054	0.968	1.074	0.935	0.114	0.983	0.085	NL	
395.8	10	5	50	0.055	1.070	5.734	11.881	0.130	0.055	1.104	1.366	0.935	0.122	0.977	0.094	NL	
393.3	12.5	6	20	0.057	1.210	6.643	10.785	0.120	0.057	1.244	1.662	0.935	0.112	0.971	0.101	1.109	
390.8	15	7	20	0.058	1.354	7.515	11.727	0.129	0.058	1.388	1.962	0.935	0.121	0.966	0.107	1.131	
388.3	17.5	11	35	0.062	1.504	11.488	18.786	0.201	0.062	1.538	2.268	0.935	0.188	0.960	0.110	1.709	
385.8	20	15	12	0.065	1.663	15.263	17.298	0.184	0.065	1.697	2.583	0.935	0.172	0.954	0.113	1.522	
383.3	22.5	7	12	0.058	1.817	6.978	8.752	0.102	0.058	1.851	2.893	0.935	0.095	0.948	0.116	0.819	
380.8	25	18	5	0.066	1.972	17.626	17.626	0.188	0.066	2.006	3.204	0.935	0.176	0.943	0.117	1.504	
378.3	27.5	16	5	0.065	2.136	15.399	15.399	0.164	0.065	2.170	3.524	0.931	0.153	0.937	0.119	1.286	
375.8	30	29	5	0.071	2.306	27.003	27.003	0.338	0.071	2.340	3.850	0.917	0.310	0.931	0.119	N60cs>25	
373.3	32.5	33	5	0.072	2.485	29.601	29.601	0.442	0.072	2.519	4.185	0.903	0.399	0.911	0.118	N60cs>25	
370.8	35	20	5	0.067	2.659	17.343	17.343	0.185	0.067	2.693	4.515	0.891	0.165	0.891	0.117	1.410	
368.3	37.5	21	5	0.068	2.828	17.657	17.657	0.188	0.068	2.862	4.840	0.881	0.166	0.870	0.115	1.443	
365.8	40	11	5	0.062	2.991	8.994	8.994	0.104	0.062	3.025	5.159	0.871	0.091	0.850	0.113	0.805	
363.3	42.5	23	5	0.068	3.154	18.312	18.312	0.195	0.068	3.188	5.478	0.862	0.168	0.830	0.111	1.514	
360.8	45	17	5	0.066	3.322	13.189	13.189	0.142	0.066	3.356	5.802	0.853	0.121	0.810	0.109	1.110	
358.3	47.5	23	5	0.068	3.490	17.409	17.409	0.185	0.068	3.524	6.126	0.845	0.156	0.789	0.107	1.458	
355.8	50	20	5	0.067	3.659	14.784	14.784	0.158	0.067	3.693	6.451	0.837	0.132	0.769	0.105	1.257	
353.3	52.5	25	5	0.069	3.829	18.065	18.065	0.193	0.069	3.863	6.777	0.829	0.160	0.749	0.102	1.569	
350.8	55	39	5	0.073	4.007	26.783	26.783	0.332	0.073	4.041	7.111	0.822	0.273	0.729	0.100	N60cs>25	
348.3	57.5	26	5	0.070	4.186	17.370	17.370	0.185	0.070	4.220	7.446	0.815	0.151	0.708	0.097	1.557	
345.8	60	31	5	0.071	4.362	20.172	20.172	0.218	0.071	4.396	7.778	0.808	0.176	0.688	0.095	1.853	
343.3	62.5	38	5	0.073	4.542	24.085	24.085	0.275	0.073	4.576	8.114	0.802	0.221	0.668	0.092	2.402	
340.8	65	39	5	0.073	4.725	24.084	24.084	0.275	0.073	4.759	8.453	0.795	0.219	0.648	0.090	2.433	
338.3	67.5	33	5	0.072	4.906	19.874	19.874	0.214	0.072	4.940	8.790	0.789	0.169	0.627	0.087	1.943	
335.8	70	38	12	0.073	5.087	22.332	24.591	0.284	0.073	5.121	9.127	0.784	0.223	0.607	0.084	2.655	
333.3	72.5	52	5	0.076	5.273	29.819	29.819	0.455	0.076	5.307	9.469	0.778	0.354	0.587	0.082	N60cs>25	
330.8	75	43	5	0.074	5.461	24.068	24.068	0.275	0.074	5.495	9.813	0.773	0.213	0.567	0.079	2.696	
328.3	77.5	24	12	0.069	5.640	13.134	15.102	0.161	0.069	5.674	10.148	0.768	0.124	0.546	0.076	1.632	
325.8	80	16	12	0.065	5.808	8.577	10.401	0.117	0.065	5.842	10.472	0.763	0.089	0.526	0.074	1.203	

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-06** **2500 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.80** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.80** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.260** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **6.0** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.770</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
403.3	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	0.472	0.472	1.770	0.274	0.994	0.168	ABO. WAT.	
400.8	5	7	50	0.115	0.585	9.455	16.346	0.174	0.115	0.757	0.757	1.770	0.308	0.989	0.167	ABO. WAT.	
398.3	7.5	4	50	0.109	0.865	4.967	10.960	0.122	0.054	0.968	1.074	1.770	0.216	0.983	0.184	NL	
395.8	10	5	50	0.055	1.070	5.734	11.881	0.130	0.055	1.104	1.366	1.770	0.230	0.977	0.204	NL	
393.3	12.5	6	20	0.057	1.210	6.643	10.785	0.120	0.057	1.244	1.662	1.770	0.212	0.971	0.219	0.968	
390.8	15	7	20	0.058	1.354	7.515	11.727	0.129	0.058	1.388	1.962	1.770	0.228	0.966	0.231	0.987	
388.3	17.5	11	35	0.062	1.504	11.488	18.786	0.201	0.062	1.538	2.268	1.770	0.356	0.960	0.239	1.490	
385.8	20	15	12	0.065	1.663	15.263	17.298	0.184	0.065	1.697	2.583	1.770	0.326	0.954	0.245	1.331	
383.3	22.5	7	12	0.058	1.817	6.978	8.752	0.102	0.058	1.851	2.893	1.770	0.181	0.948	0.250	0.724	
380.8	25	18	5	0.066	1.972	17.626	17.626	0.188	0.066	2.006	3.204	1.770	0.333	0.943	0.255	1.306	
378.3	27.5	16	5	0.065	2.136	15.399	15.399	0.164	0.065	2.170	3.524	1.762	0.289	0.937	0.257	1.125	
375.8	30	29	5	0.071	2.306	27.003	27.003	0.338	0.071	2.340	3.850	1.735	0.586	0.931	0.259	N60cs>25	
373.3	32.5	33	5	0.072	2.485	29.601	29.601	0.442	0.072	2.519	4.185	1.710	0.756	0.911	0.256	N60cs>25	
370.8	35	20	5	0.067	2.659	17.343	17.343	0.185	0.067	2.693	4.515	1.687	0.312	0.891	0.252	1.238	
368.3	37.5	21	5	0.068	2.828	17.657	17.657	0.188	0.068	2.862	4.840	1.667	0.313	0.870	0.249	1.257	
365.8	40	11	5	0.062	2.991	8.994	8.994	0.104	0.062	3.025	5.159	1.649	0.171	0.850	0.245	0.698	
363.3	42.5	23	5	0.068	3.154	18.312	18.312	0.195	0.068	3.188	5.478	1.631	0.318	0.830	0.241	1.320	
360.8	45	17	5	0.066	3.322	13.189	13.189	0.142	0.066	3.356	5.802	1.615	0.229	0.810	0.237	0.966	
358.3	47.5	23	5	0.068	3.490	17.409	17.409	0.185	0.068	3.524	6.126	1.599	0.296	0.789	0.232	1.276	
355.8	50	20	5	0.067	3.659	14.784	14.784	0.158	0.067	3.693	6.451	1.584	0.250	0.769	0.227	1.101	
353.3	52.5	25	5	0.069	3.829	18.065	18.065	0.193	0.069	3.863	6.777	1.570	0.303	0.749	0.222	1.365	
350.8	55	39	5	0.073	4.007	26.783	26.783	0.332	0.073	4.041	7.111	1.556	0.517	0.729	0.217	N60cs>25	
348.3	57.5	26	5	0.070	4.186	17.370	17.370	0.185	0.070	4.220	7.446	1.542	0.285	0.708	0.211	1.351	
345.8	60	31	5	0.071	4.362	20.172	20.172	0.218	0.071	4.396	7.778	1.530	0.334	0.688	0.206	1.621	
343.3	62.5	38	5	0.073	4.542	24.085	24.085	0.275	0.073	4.576	8.114	1.518	0.417	0.668	0.200	2.085	
340.8	65	39	5	0.073	4.725	24.084	24.084	0.275	0.073	4.759	8.453	1.506	0.414	0.648	0.195	2.123	
338.3	67.5	33	5	0.072	4.906	19.874	19.874	0.214	0.072	4.940	8.790	1.494	0.320	0.627	0.189	1.693	
335.8	70	38	12	0.073	5.087	22.332	24.591	0.284	0.073	5.121	9.127	1.484	0.421	0.607	0.183	2.301	
333.3	72.5	52	5	0.076	5.273	29.819	29.819	0.455	0.076	5.307	9.469	1.473	0.670	0.587	0.177	N60cs>25	
330.8	75	43	5	0.074	5.461	24.068	24.068	0.275	0.074	5.495	9.813	1.463	0.402	0.567	0.171	2.351	
328.3	77.5	24	12	0.069	5.640	13.134	15.102	0.161	0.069	5.674	10.148	1.454	0.234	0.546	0.165	1.418	
325.8	80	16	12	0.065	5.808	8.577	10.401	0.117	0.065	5.842	10.472	1.445	0.169	0.526	0.159	1.063	

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-07** **1000 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.70** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.100** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.5** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.000</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)		Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)				
403.2	2.5	9	50	0.117	0.300	11.815	19.178	0.205	0.117	0.466	0.466	1.000	0.205	0.994	0.065	ABO. WAT.
400.7	5	5	50	0.111	0.585	6.753	13.104	0.142	0.111	0.751	0.751	1.000	0.142	0.989	0.064	ABO. WAT.
398.2	7.5	10	35	0.118	0.871	12.375	19.850	0.214	0.061	0.966	1.078	1.000	0.214	0.983	0.071	3.014
395.7	10	2	35	0.049	1.080	2.283	7.740	0.094	0.049	1.104	1.372	1.000	0.094	0.977	0.079	1.190
393.2	12.5	14	50	0.064	1.221	15.429	23.515	0.265	0.064	1.245	1.669	1.000	0.265	0.971	0.085	NL
390.7	15	8	12	0.059	1.375	8.523	10.346	0.116	0.059	1.399	1.979	1.000	0.116	0.966	0.089	1.303
388.2	17.5	11	6	0.062	1.526	11.404	11.487	0.126	0.062	1.550	2.286	1.000	0.126	0.960	0.092	1.370
385.7	20	16	50	0.065	1.685	16.174	24.409	0.281	0.065	1.709	2.601	1.000	0.281	0.954	0.094	NL
383.2	22.5	8	6	0.059	1.840	7.924	7.991	0.096	0.059	1.864	2.912	1.000	0.096	0.948	0.096	1.000
380.7	25	18	6	0.066	1.996	17.520	17.632	0.188	0.066	2.020	3.224	1.000	0.188	0.943	0.098	1.918
378.2	27.5	9	6	0.060	2.154	8.625	8.695	0.102	0.060	2.178	3.538	0.995	0.101	0.937	0.099	1.020
375.7	30	8	6	0.059	2.303	7.454	7.519	0.092	0.059	2.327	3.843	0.982	0.090	0.931	0.100	0.900
373.2	32.5	24	6	0.069	2.463	21.624	21.755	0.239	0.069	2.487	4.159	0.969	0.232	0.911	0.099	2.343
370.7	35	34	6	0.072	2.639	29.594	29.763	0.452	0.072	2.663	4.491	0.955	0.432	0.891	0.098	N60cs>25
368.2	37.5	23	6	0.068	2.814	19.387	19.508	0.209	0.068	2.838	4.822	0.943	0.197	0.870	0.096	2.052
365.7	40	25	6	0.069	2.985	20.461	20.587	0.223	0.069	3.009	5.149	0.932	0.208	0.850	0.095	2.189
363.2	42.5	26	6	0.070	3.159	20.685	20.812	0.226	0.070	3.183	5.479	0.922	0.208	0.830	0.093	2.237
360.7	45	27	6	0.070	3.334	20.909	21.037	0.229	0.070	3.358	5.810	0.912	0.209	0.810	0.091	2.297
358.2	47.5	31	6	0.071	3.510	23.397	23.537	0.266	0.071	3.534	6.142	0.903	0.240	0.789	0.089	2.697
355.7	50	25	6	0.069	3.685	18.415	18.531	0.198	0.069	3.709	6.473	0.894	0.177	0.769	0.087	2.034
353.2	52.5	20	6	0.067	3.855	14.403	14.500	0.155	0.067	3.879	6.799	0.886	0.137	0.749	0.085	1.612
350.7	55	23	6	0.068	4.024	15.753	15.857	0.169	0.068	4.048	7.124	0.879	0.149	0.729	0.083	1.795
348.2	57.5	4	6	0.054	4.177	2.676	2.718	0.050	0.054	4.201	7.433	0.872	0.044	0.708	0.081	0.543
345.7	60	7	12	0.058	4.317	4.585	6.283	0.082	0.058	4.341	7.729	0.866	0.071	0.688	0.080	0.888
343.2	62.5	23	6	0.068	4.475	14.720	14.819	0.158	0.068	4.499	8.043	0.860	0.136	0.668	0.078	1.744
340.7	65	31	6	0.071	4.649	19.350	19.471	0.209	0.071	4.673	8.373	0.854	0.178	0.648	0.075	2.373
338.2	67.5	49	6	0.076	4.833	29.808	29.978	0.466	0.076	4.857	8.713	0.847	0.395	0.627	0.073	N60cs>25
335.7	70	42	6	0.074	5.021	24.902	25.049	0.293	0.074	5.045	9.057	0.841	0.246	0.607	0.071	N60cs>25
333.2	72.5	73	6	0.079	5.212	42.197	42.425	1.000	0.079	5.236	9.404	0.835	0.835	0.587	0.069	N60cs>25
330.7	75	33	6	0.072	5.401	18.613	18.730	0.200	0.072	5.425	9.749	0.829	0.166	0.567	0.066	2.515
328.2	77.5	26	12	0.070	5.579	14.338	16.344	0.174	0.070	5.603	10.083	0.823	0.143	0.546	0.064	2.234
325.7	80	15	12	0.065	5.748	8.100	9.909	0.112	0.065	5.772	10.408	0.818	0.092	0.526	0.062	1.484

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction



# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-07** **1000 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.70** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.190** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **5.6** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 2.112</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)		Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)				
403.2	2.5	9	50	0.117	0.300	11.815	19.178	0.205	0.117	0.466	0.466	2.112	0.433	0.994	0.123	ABO. WAT.
400.7	5	5	50	0.111	0.585	6.753	13.104	0.142	0.111	0.751	0.751	2.112	0.300	0.989	0.122	ABO. WAT.
398.2	7.5	10	35	0.118	0.871	12.375	19.850	0.214	0.061	0.966	1.078	2.112	0.452	0.983	0.135	3.348
395.7	10	2	35	0.049	1.080	2.283	7.740	0.094	0.049	1.104	1.372	2.112	0.199	0.977	0.150	1.327
393.2	12.5	14	50	0.064	1.221	15.429	23.515	0.265	0.064	1.245	1.669	2.112	0.560	0.971	0.161	NL
390.7	15	8	12	0.059	1.375	8.523	10.346	0.116	0.059	1.399	1.979	2.112	0.245	0.966	0.169	1.450
388.2	17.5	11	6	0.062	1.526	11.404	11.487	0.126	0.062	1.550	2.286	2.112	0.266	0.960	0.175	1.520
385.7	20	16	50	0.065	1.685	16.174	24.409	0.281	0.065	1.709	2.601	2.112	0.593	0.954	0.179	NL
383.2	22.5	8	6	0.059	1.840	7.924	7.991	0.096	0.059	1.864	2.912	2.112	0.203	0.948	0.183	1.109
380.7	25	18	6	0.066	1.996	17.520	17.632	0.188	0.066	2.020	3.224	2.112	0.397	0.943	0.186	2.134
378.2	27.5	9	6	0.060	2.154	8.625	8.695	0.102	0.060	2.178	3.538	2.101	0.214	0.937	0.188	1.138
375.7	30	8	6	0.059	2.303	7.454	7.519	0.092	0.059	2.327	3.843	2.073	0.191	0.931	0.190	1.005
373.2	32.5	24	6	0.069	2.463	21.624	21.755	0.239	0.069	2.487	4.159	2.046	0.489	0.911	0.188	2.601
370.7	35	34	6	0.072	2.639	29.594	29.763	0.452	0.072	2.663	4.491	2.018	0.912	0.891	0.186	N60cs>25
368.2	37.5	23	6	0.068	2.814	19.387	19.508	0.209	0.068	2.838	4.822	1.992	0.416	0.870	0.183	2.273
365.7	40	25	6	0.069	2.985	20.461	20.587	0.223	0.069	3.009	5.149	1.969	0.439	0.850	0.180	2.439
363.2	42.5	26	6	0.070	3.159	20.685	20.812	0.226	0.070	3.183	5.479	1.947	0.440	0.830	0.176	2.500
360.7	45	27	6	0.070	3.334	20.909	21.037	0.229	0.070	3.358	5.810	1.926	0.441	0.810	0.173	2.549
358.2	47.5	31	6	0.071	3.510	23.397	23.537	0.266	0.071	3.534	6.142	1.907	0.507	0.789	0.169	3.000
355.7	50	25	6	0.069	3.685	18.415	18.531	0.198	0.069	3.709	6.473	1.888	0.374	0.769	0.166	2.253
353.2	52.5	20	6	0.067	3.855	14.403	14.500	0.155	0.067	3.879	6.799	1.872	0.290	0.749	0.162	1.790
350.7	55	23	6	0.068	4.024	15.753	15.857	0.169	0.068	4.048	7.124	1.856	0.314	0.729	0.158	1.987
348.2	57.5	4	6	0.054	4.177	2.676	2.718	0.050	0.054	4.201	7.433	1.842	0.092	0.708	0.155	0.594
345.7	60	7	12	0.058	4.317	4.585	6.283	0.082	0.058	4.341	7.729	1.830	0.150	0.688	0.151	0.993
343.2	62.5	23	6	0.068	4.475	14.720	14.819	0.158	0.068	4.499	8.043	1.817	0.287	0.668	0.147	1.952
340.7	65	31	6	0.071	4.649	19.350	19.471	0.209	0.071	4.673	8.373	1.803	0.377	0.648	0.143	2.636
338.2	67.5	49	6	0.076	4.833	29.808	29.978	0.466	0.076	4.857	8.713	1.789	0.834	0.627	0.139	N60cs>25
335.7	70	42	6	0.074	5.021	24.902	25.049	0.293	0.074	5.045	9.057	1.776	0.520	0.607	0.135	N60cs>25
333.2	72.5	73	6	0.079	5.212	42.197	42.425	1.000	0.079	5.236	9.404	1.763	1.763	0.587	0.130	N60cs>25
330.7	75	33	6	0.072	5.401	18.613	18.730	0.200	0.072	5.425	9.749	1.750	0.350	0.567	0.126	2.778
328.2	77.5	26	12	0.070	5.579	14.338	16.344	0.174	0.070	5.603	10.083	1.739	0.303	0.546	0.121	2.504
325.7	80	15	12	0.065	5.748	8.100	9.909	0.112	0.065	5.772	10.408	1.729	0.194	0.526	0.117	1.658

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-07** **2500 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.70** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.120** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.7** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 0.935</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)		Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)				
403.2	2.5	9	50	0.117	0.300	11.815	19.178	0.205	0.117	0.466	0.466	0.935	0.192	0.994	0.078	ABO. WAT.
400.7	5	5	50	0.111	0.585	6.753	13.104	0.142	0.111	0.751	0.751	0.935	0.133	0.989	0.077	ABO. WAT.
398.2	7.5	10	35	0.118	0.871	12.375	19.850	0.214	0.061	0.966	1.078	0.935	0.200	0.983	0.086	2.326
395.7	10	2	35	0.049	1.080	2.283	7.740	0.094	0.049	1.104	1.372	0.935	0.088	0.977	0.095	0.926
393.2	12.5	14	50	0.064	1.221	15.429	23.515	0.265	0.064	1.245	1.669	0.935	0.248	0.971	0.102	NL
390.7	15	8	12	0.059	1.375	8.523	10.346	0.116	0.059	1.399	1.979	0.935	0.108	0.966	0.107	1.009
388.2	17.5	11	6	0.062	1.526	11.404	11.487	0.126	0.062	1.550	2.286	0.935	0.118	0.960	0.110	1.073
385.7	20	16	50	0.065	1.685	16.174	24.409	0.281	0.065	1.709	2.601	0.935	0.263	0.954	0.113	NL
383.2	22.5	8	6	0.059	1.840	7.924	7.991	0.096	0.059	1.864	2.912	0.935	0.090	0.948	0.116	0.776
380.7	25	18	6	0.066	1.996	17.520	17.632	0.188	0.066	2.020	3.224	0.935	0.176	0.943	0.117	1.504
378.2	27.5	9	6	0.060	2.154	8.625	8.695	0.102	0.060	2.178	3.538	0.930	0.095	0.937	0.119	0.798
375.7	30	8	6	0.059	2.303	7.454	7.519	0.092	0.059	2.327	3.843	0.918	0.084	0.931	0.120	0.700
373.2	32.5	24	6	0.069	2.463	21.624	21.755	0.239	0.069	2.487	4.159	0.906	0.217	0.911	0.119	1.824
370.7	35	34	6	0.072	2.639	29.594	29.763	0.452	0.072	2.663	4.491	0.893	0.404	0.891	0.117	N60cs>25
368.2	37.5	23	6	0.068	2.814	19.387	19.508	0.209	0.068	2.838	4.822	0.882	0.184	0.870	0.115	1.600
365.7	40	25	6	0.069	2.985	20.461	20.587	0.223	0.069	3.009	5.149	0.872	0.194	0.850	0.113	1.717
363.2	42.5	26	6	0.070	3.159	20.685	20.812	0.226	0.070	3.183	5.479	0.862	0.195	0.830	0.111	1.757
360.7	45	27	6	0.070	3.334	20.909	21.037	0.229	0.070	3.358	5.810	0.853	0.195	0.810	0.109	1.789
358.2	47.5	31	6	0.071	3.510	23.397	23.537	0.266	0.071	3.534	6.142	0.844	0.225	0.789	0.107	2.103
355.7	50	25	6	0.069	3.685	18.415	18.531	0.198	0.069	3.709	6.473	0.836	0.166	0.769	0.105	1.581
353.2	52.5	20	6	0.067	3.855	14.403	14.500	0.155	0.067	3.879	6.799	0.829	0.128	0.749	0.102	1.255
350.7	55	23	6	0.068	4.024	15.753	15.857	0.169	0.068	4.048	7.124	0.822	0.139	0.729	0.100	1.390
348.2	57.5	4	6	0.054	4.177	2.676	2.718	0.050	0.054	4.201	7.433	0.815	0.041	0.708	0.098	0.418
345.7	60	7	12	0.058	4.317	4.585	6.283	0.082	0.058	4.341	7.729	0.810	0.066	0.688	0.096	0.688
343.2	62.5	23	6	0.068	4.475	14.720	14.819	0.158	0.068	4.499	8.043	0.804	0.127	0.668	0.093	1.366
340.7	65	31	6	0.071	4.649	19.350	19.471	0.209	0.071	4.673	8.373	0.798	0.167	0.648	0.091	1.835
338.2	67.5	49	6	0.076	4.833	29.808	29.978	0.466	0.076	4.857	8.713	0.792	0.369	0.627	0.088	N60cs>25
335.7	70	42	6	0.074	5.021	24.902	25.049	0.293	0.074	5.045	9.057	0.786	0.230	0.607	0.085	N60cs>25
333.2	72.5	73	6	0.079	5.212	42.197	42.425	1.000	0.079	5.236	9.404	0.780	0.780	0.587	0.082	N60cs>25
330.7	75	33	6	0.072	5.401	18.613	18.730	0.200	0.072	5.425	9.749	0.775	0.155	0.567	0.079	1.962
328.2	77.5	26	12	0.070	5.579	14.338	16.344	0.174	0.070	5.603	10.083	0.770	0.134	0.546	0.077	1.740
325.7	80	15	12	0.065	5.748	8.100	9.909	0.112	0.065	5.772	10.408	0.765	0.086	0.526	0.074	1.162

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-07** **2500 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.70** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.260** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **6.0** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.770</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
403.2	2.5	9	50	0.117	0.300	11.815	19.178	0.205	0.117	0.466	0.466	1.770	0.363	0.994	0.168	ABO. WAT.
400.7	5	5	50	0.111	0.585	6.753	13.104	0.142	0.111	0.751	0.751	1.770	0.251	0.989	0.167	ABO. WAT.
398.2	7.5	10	35	0.118	0.871	12.375	19.850	0.214	0.061	0.966	1.078	1.770	0.379	0.983	0.185	2.049
395.7	10	2	35	0.049	1.080	2.283	7.740	0.094	0.049	1.104	1.372	1.770	0.166	0.977	0.205	0.810
393.2	12.5	14	50	0.064	1.221	15.429	23.515	0.265	0.064	1.245	1.669	1.770	0.469	0.971	0.220	NL
390.7	15	8	12	0.059	1.375	8.523	10.346	0.116	0.059	1.399	1.979	1.770	0.205	0.966	0.231	0.887
388.2	17.5	11	6	0.062	1.526	11.404	11.487	0.126	0.062	1.550	2.286	1.770	0.223	0.960	0.239	0.933
385.7	20	16	50	0.065	1.685	16.174	24.409	0.281	0.065	1.709	2.601	1.770	0.497	0.954	0.245	NL
383.2	22.5	8	6	0.059	1.840	7.924	7.991	0.096	0.059	1.864	2.912	1.770	0.170	0.948	0.250	0.680
380.7	25	18	6	0.066	1.996	17.520	17.632	0.188	0.066	2.020	3.224	1.770	0.333	0.943	0.254	1.311
378.2	27.5	9	6	0.060	2.154	8.625	8.695	0.102	0.060	2.178	3.538	1.760	0.180	0.937	0.257	0.700
375.7	30	8	6	0.059	2.303	7.454	7.519	0.092	0.059	2.327	3.843	1.737	0.160	0.931	0.260	0.615
373.2	32.5	24	6	0.069	2.463	21.624	21.755	0.239	0.069	2.487	4.159	1.714	0.410	0.911	0.257	1.595
370.7	35	34	6	0.072	2.639	29.594	29.763	0.452	0.072	2.663	4.491	1.691	0.764	0.891	0.254	N60cs>25
368.2	37.5	23	6	0.068	2.814	19.387	19.508	0.209	0.068	2.838	4.822	1.670	0.349	0.870	0.250	1.396
365.7	40	25	6	0.069	2.985	20.461	20.587	0.223	0.069	3.009	5.149	1.650	0.368	0.850	0.246	1.496
363.2	42.5	26	6	0.070	3.159	20.685	20.812	0.226	0.070	3.183	5.479	1.632	0.369	0.830	0.241	1.531
360.7	45	27	6	0.070	3.334	20.909	21.037	0.229	0.070	3.358	5.810	1.614	0.370	0.810	0.237	1.561
358.2	47.5	31	6	0.071	3.510	23.397	23.537	0.266	0.071	3.534	6.142	1.598	0.425	0.789	0.232	1.832
355.7	50	25	6	0.069	3.685	18.415	18.531	0.198	0.069	3.709	6.473	1.583	0.313	0.769	0.227	1.379
353.2	52.5	20	6	0.067	3.855	14.403	14.500	0.155	0.067	3.879	6.799	1.569	0.243	0.749	0.222	1.095
350.7	55	23	6	0.068	4.024	15.753	15.857	0.169	0.068	4.048	7.124	1.555	0.263	0.729	0.217	1.212
348.2	57.5	4	6	0.054	4.177	2.676	2.718	0.050	0.054	4.201	7.433	1.544	0.077	0.708	0.212	0.363
345.7	60	7	12	0.058	4.317	4.585	6.283	0.082	0.058	4.341	7.729	1.534	0.126	0.688	0.207	0.609
343.2	62.5	23	6	0.068	4.475	14.720	14.819	0.158	0.068	4.499	8.043	1.523	0.241	0.668	0.202	1.193
340.7	65	31	6	0.071	4.649	19.350	19.471	0.209	0.071	4.673	8.373	1.511	0.316	0.648	0.196	1.612
338.2	67.5	49	6	0.076	4.833	29.808	29.978	0.466	0.076	4.857	8.713	1.500	0.699	0.627	0.190	N60cs>25
335.7	70	42	6	0.074	5.021	24.902	25.049	0.293	0.074	5.045	9.057	1.488	0.436	0.607	0.184	N60cs>25
333.2	72.5	73	6	0.079	5.212	42.197	42.425	1.000	0.079	5.236	9.404	1.477	1.477	0.587	0.178	N60cs>25
330.7	75	33	6	0.072	5.401	18.613	18.730	0.200	0.072	5.425	9.749	1.467	0.293	0.567	0.172	1.703
328.2	77.5	26	12	0.070	5.579	14.338	16.344	0.174	0.070	5.603	10.083	1.457	0.254	0.546	0.166	1.530
325.7	80	15	12	0.065	5.748	8.100	9.909	0.112	0.065	5.772	10.408	1.449	0.162	0.526	0.160	1.013

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-08** **1000 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.30** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.30** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.100** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.5** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.000</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value N (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
402.8	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	0.446	0.446	1.000	0.139	0.994	0.065	ABO. WAT.
400.3	5	5	50	0.111	0.578	6.753	13.104	0.142	0.111	0.724	0.724	1.000	0.142	0.989	0.064	ABO. WAT.
397.8	7.5	5	50	0.111	0.856	6.241	12.489	0.136	0.055	0.932	1.069	1.000	0.136	0.983	0.073	NL
395.3	10	7	6	0.058	1.067	8.039	8.106	0.097	0.058	1.073	1.366	1.000	0.097	0.977	0.081	1.198
392.8	12.5	7	6	0.058	1.212	7.743	7.809	0.094	0.058	1.218	1.667	1.000	0.094	0.971	0.086	1.093
390.3	15	6	6	0.057	1.356	6.437	6.497	0.084	0.057	1.362	1.967	1.000	0.084	0.966	0.091	0.923
387.8	17.5	11	6	0.062	1.505	11.484	11.568	0.127	0.062	1.511	2.272	1.000	0.127	0.960	0.094	1.351
385.3	20	6	50	0.057	1.654	6.122	12.346	0.134	0.057	1.660	2.577	1.000	0.134	0.954	0.096	NL
382.8	22.5	6	50	0.057	1.797	6.014	12.217	0.133	0.057	1.803	2.876	1.000	0.133	0.948	0.098	NL
380.3	25	27	6	0.070	1.956	26.547	26.701	0.330	0.070	1.962	3.191	1.000	0.330	0.943	0.100	N60cs>25
377.8	27.5	15	6	0.065	2.125	14.474	14.572	0.156	0.065	2.131	3.516	0.999	0.156	0.937	0.100	1.560
375.3	30	26	6	0.070	2.294	24.273	24.417	0.281	0.070	2.300	3.841	0.984	0.277	0.931	0.101	2.743
372.8	32.5	30	6	0.071	2.470	26.991	27.147	0.343	0.071	2.476	4.173	0.969	0.332	0.911	0.100	N60cs>25
370.3	35	23	6	0.068	2.644	20.001	20.125	0.217	0.068	2.650	4.503	0.956	0.207	0.891	0.098	2.112
367.8	37.5	27	6	0.070	2.817	22.747	22.884	0.255	0.070	2.823	4.832	0.944	0.241	0.870	0.097	2.485
365.3	40	31	6	0.071	2.993	25.337	25.486	0.302	0.071	2.999	5.164	0.933	0.282	0.850	0.095	N60cs>25
362.8	42.5	28	6	0.070	3.169	22.241	22.375	0.247	0.070	3.175	5.496	0.922	0.228	0.830	0.093	2.452
360.3	45	22	6	0.068	3.342	17.016	17.126	0.182	0.068	3.348	5.825	0.913	0.166	0.810	0.092	1.804
357.8	47.5	29	6	0.071	3.516	21.869	22.001	0.242	0.071	3.522	6.155	0.903	0.219	0.789	0.090	2.433
355.3	50	34	6	0.072	3.695	25.010	25.157	0.295	0.072	3.701	6.490	0.895	0.264	0.769	0.088	N60cs>25
352.8	52.5	32	6	0.071	3.874	22.989	23.127	0.259	0.071	3.880	6.825	0.886	0.229	0.749	0.086	2.663
350.3	55	32	6	0.071	4.052	21.823	21.955	0.241	0.071	4.058	7.159	0.878	0.212	0.729	0.084	2.524
347.8	57.5	30	6	0.071	4.230	19.910	20.033	0.216	0.071	4.236	7.493	0.871	0.188	0.708	0.081	2.321
345.3	60	30	6	0.071	4.408	19.389	19.510	0.209	0.071	4.414	7.827	0.864	0.181	0.688	0.079	2.291
342.8	62.5	27	6	0.070	4.584	17.010	17.120	0.182	0.070	4.590	8.159	0.857	0.156	0.668	0.077	2.026
340.3	65	49	6	0.076	4.767	30.082	30.253	1.000	0.076	4.773	8.498	0.850	0.850	0.648	0.075	N60cs>25
337.8	67.5	58	6	0.077	4.958	34.683	34.876	1.000	0.077	4.964	8.845	0.844	0.844	0.627	0.073	N60cs>25
335.3	70	54	6	0.076	5.149	31.474	31.651	1.000	0.076	5.155	9.192	0.837	0.837	0.607	0.070	N60cs>25
332.8	72.5	46	6	0.075	5.338	26.157	26.310	0.320	0.075	5.344	9.537	0.831	0.266	0.587	0.068	N60cs>25
330.3	75	29	6	0.071	5.521	16.109	16.214	0.172	0.071	5.527	9.876	0.826	0.142	0.567	0.066	2.152
327.8	77.5	24	12	0.069	5.696	13.043	15.008	0.160	0.069	5.702	10.207	0.820	0.131	0.546	0.064	2.047
325.3	80	15	12	0.065	5.864	7.986	9.792	0.111	0.065	5.870	10.531	0.816	0.091	0.526	0.061	1.492

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-08** **1000 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.30** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.30** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.190** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **5.6** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 2.112</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
402.8	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	0.446	0.446	2.112	0.294	0.994	0.123	ABO. WAT.
400.3	5	5	50	0.111	0.578	6.753	13.104	0.142	0.111	0.724	0.724	2.112	0.300	0.989	0.122	ABO. WAT.
397.8	7.5	5	50	0.111	0.856	6.241	12.489	0.136	0.055	0.932	1.069	2.112	0.287	0.983	0.139	NL
395.3	10	7	6	0.058	1.067	8.039	8.106	0.097	0.058	1.073	1.366	2.112	0.205	0.977	0.154	1.331
392.8	12.5	7	6	0.058	1.212	7.743	7.809	0.094	0.058	1.218	1.667	2.112	0.199	0.971	0.164	1.213
390.3	15	6	6	0.057	1.356	6.437	6.497	0.084	0.057	1.362	1.967	2.112	0.177	0.966	0.172	1.029
387.8	17.5	11	6	0.062	1.505	11.484	11.568	0.127	0.062	1.511	2.272	2.112	0.268	0.960	0.178	1.506
385.3	20	6	50	0.057	1.654	6.122	12.346	0.134	0.057	1.660	2.577	2.112	0.283	0.954	0.183	NL
382.8	22.5	6	50	0.057	1.797	6.014	12.217	0.133	0.057	1.803	2.876	2.112	0.281	0.948	0.187	NL
380.3	25	27	6	0.070	1.956	26.547	26.701	0.330	0.070	1.962	3.191	2.112	0.697	0.943	0.189	N60cs>25
377.8	27.5	15	6	0.065	2.125	14.474	14.572	0.156	0.065	2.131	3.516	2.110	0.329	0.937	0.191	1.723
375.3	30	26	6	0.070	2.294	24.273	24.417	0.281	0.070	2.300	3.841	2.078	0.584	0.931	0.192	3.042
372.8	32.5	30	6	0.071	2.470	26.991	27.147	0.343	0.071	2.476	4.173	2.047	0.702	0.911	0.190	N60cs>25
370.3	35	23	6	0.068	2.644	20.001	20.125	0.217	0.068	2.650	4.503	2.020	0.438	0.891	0.187	2.342
367.8	37.5	27	6	0.070	2.817	22.747	22.884	0.255	0.070	2.823	4.832	1.994	0.508	0.870	0.184	2.761
365.3	40	31	6	0.071	2.993	25.337	25.486	0.302	0.071	2.999	5.164	1.970	0.595	0.850	0.181	N60cs>25
362.8	42.5	28	6	0.070	3.169	22.241	22.375	0.247	0.070	3.175	5.496	1.948	0.481	0.830	0.177	2.718
360.3	45	22	6	0.068	3.342	17.016	17.126	0.182	0.068	3.348	5.825	1.928	0.351	0.810	0.174	2.017
357.8	47.5	29	6	0.071	3.516	21.869	22.001	0.242	0.071	3.522	6.155	1.908	0.462	0.789	0.170	2.718
355.3	50	34	6	0.072	3.695	25.010	25.157	0.295	0.072	3.701	6.490	1.889	0.557	0.769	0.167	N60cs>25
352.8	52.5	32	6	0.071	3.874	22.989	23.127	0.259	0.071	3.880	6.825	1.872	0.485	0.749	0.163	2.975
350.3	55	32	6	0.071	4.052	21.823	21.955	0.241	0.071	4.058	7.159	1.855	0.447	0.729	0.159	2.811
347.8	57.5	30	6	0.071	4.230	19.910	20.033	0.216	0.071	4.236	7.493	1.839	0.397	0.708	0.155	2.561
345.3	60	30	6	0.071	4.408	19.389	19.510	0.209	0.071	4.414	7.827	1.824	0.381	0.688	0.151	2.523
342.8	62.5	27	6	0.070	4.584	17.010	17.120	0.182	0.070	4.590	8.159	1.810	0.329	0.668	0.147	2.238
340.3	65	49	6	0.076	4.767	30.082	30.253	1.000	0.076	4.773	8.498	1.796	1.796	0.648	0.142	N60cs>25
337.8	67.5	58	6	0.077	4.958	34.683	34.876	1.000	0.077	4.964	8.845	1.782	1.782	0.627	0.138	N60cs>25
335.3	70	54	6	0.076	5.149	31.474	31.651	1.000	0.076	5.155	9.192	1.768	1.768	0.607	0.134	N60cs>25
332.8	72.5	46	6	0.075	5.338	26.157	26.310	0.320	0.075	5.344	9.537	1.755	0.562	0.587	0.129	N60cs>25
330.3	75	29	6	0.071	5.521	16.109	16.214	0.172	0.071	5.527	9.876	1.744	0.300	0.567	0.125	2.400
327.8	77.5	24	12	0.069	5.696	13.043	15.008	0.160	0.069	5.702	10.207	1.733	0.277	0.546	0.121	2.289
325.3	80	15	12	0.065	5.864	7.986	9.792	0.111	0.065	5.870	10.531	1.723	0.191	0.526	0.117	1.632

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-08** **2500 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.30** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.30** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.120** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.7** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 0.935</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
402.8	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	0.446	0.446	0.935	0.130	0.994	0.078	ABO. WAT.	
400.3	5	5	50	0.111	0.578	6.753	13.104	0.142	0.111	0.724	0.724	0.935	0.133	0.989	0.077	ABO. WAT.	
397.8	7.5	5	50	0.111	0.856	6.241	12.489	0.136	0.055	0.932	1.069	0.935	0.127	0.983	0.088	NL	
395.3	10	7	6	0.058	1.067	8.039	8.106	0.097	0.058	1.073	1.366	0.935	0.091	0.977	0.097	0.938	
392.8	12.5	7	6	0.058	1.212	7.743	7.809	0.094	0.058	1.218	1.667	0.935	0.088	0.971	0.104	0.846	
390.3	15	6	6	0.057	1.356	6.437	6.497	0.084	0.057	1.362	1.967	0.935	0.079	0.966	0.109	0.725	
387.8	17.5	11	6	0.062	1.505	11.484	11.568	0.127	0.062	1.511	2.272	0.935	0.119	0.960	0.113	1.053	
385.3	20	6	50	0.057	1.654	6.122	12.346	0.134	0.057	1.660	2.577	0.935	0.125	0.954	0.116	NL	
382.8	22.5	6	50	0.057	1.797	6.014	12.217	0.133	0.057	1.803	2.876	0.935	0.124	0.948	0.118	NL	
380.3	25	27	6	0.070	1.956	26.547	26.701	0.330	0.070	1.962	3.191	0.935	0.309	0.943	0.120	N60cs>25	
377.8	27.5	15	6	0.065	2.125	14.474	14.572	0.156	0.065	2.131	3.516	0.934	0.146	0.937	0.121	1.207	
375.3	30	26	6	0.070	2.294	24.273	24.417	0.281	0.070	2.300	3.841	0.920	0.259	0.931	0.121	2.140	
372.8	32.5	30	6	0.071	2.470	26.991	27.147	0.343	0.071	2.476	4.173	0.906	0.311	0.911	0.120	N60cs>25	
370.3	35	23	6	0.068	2.644	20.001	20.125	0.217	0.068	2.650	4.503	0.894	0.194	0.891	0.118	1.644	
367.8	37.5	27	6	0.070	2.817	22.747	22.884	0.255	0.070	2.823	4.832	0.883	0.225	0.870	0.116	1.940	
365.3	40	31	6	0.071	2.993	25.337	25.486	0.302	0.071	2.999	5.164	0.872	0.263	0.850	0.114	N60cs>25	
362.8	42.5	28	6	0.070	3.169	22.241	22.375	0.247	0.070	3.175	5.496	0.862	0.213	0.830	0.112	1.902	
360.3	45	22	6	0.068	3.342	17.016	17.126	0.182	0.068	3.348	5.825	0.853	0.155	0.810	0.110	1.409	
357.8	47.5	29	6	0.071	3.516	21.869	22.001	0.242	0.071	3.522	6.155	0.845	0.204	0.789	0.108	1.889	
355.3	50	34	6	0.072	3.695	25.010	25.157	0.295	0.072	3.701	6.490	0.836	0.247	0.769	0.105	N60cs>25	
352.8	52.5	32	6	0.071	3.874	22.989	23.127	0.259	0.071	3.880	6.825	0.829	0.215	0.749	0.103	2.087	
350.3	55	32	6	0.071	4.052	21.823	21.955	0.241	0.071	4.058	7.159	0.821	0.198	0.729	0.100	1.980	
347.8	57.5	30	6	0.071	4.230	19.910	20.033	0.216	0.071	4.236	7.493	0.814	0.176	0.708	0.098	1.796	
345.3	60	30	6	0.071	4.408	19.389	19.510	0.209	0.071	4.414	7.827	0.807	0.169	0.688	0.095	1.779	
342.8	62.5	27	6	0.070	4.584	17.010	17.120	0.182	0.070	4.590	8.159	0.801	0.146	0.668	0.093	1.570	
340.3	65	49	6	0.076	4.767	30.082	30.253	1.000	0.076	4.773	8.498	0.795	0.795	0.648	0.090	N60cs>25	
337.8	67.5	58	6	0.077	4.958	34.683	34.876	1.000	0.077	4.964	8.845	0.789	0.789	0.627	0.087	N60cs>25	
335.3	70	54	6	0.076	5.149	31.474	31.651	1.000	0.076	5.155	9.192	0.783	0.783	0.607	0.084	N60cs>25	
332.8	72.5	46	6	0.075	5.338	26.157	26.310	0.320	0.075	5.344	9.537	0.777	0.249	0.587	0.082	N60cs>25	
330.3	75	29	6	0.071	5.521	16.109	16.214	0.172	0.071	5.527	9.876	0.772	0.133	0.567	0.079	1.684	
327.8	77.5	24	12	0.069	5.696	13.043	15.008	0.160	0.069	5.702	10.207	0.767	0.123	0.546	0.076	1.618	
325.3	80	15	12	0.065	5.864	7.986	9.792	0.111	0.065	5.870	10.531	0.763	0.085	0.526	0.074	1.149	

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-08** **2500 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.30** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.30** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.260** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **6.0** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<math>\alpha</math>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.770</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K $\sigma$ )(K $\alpha$ )(MSF)				
402.8	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	0.446	0.446	1.770	0.246	0.994	0.168	ABO. WAT.
400.3	5	5	50	0.111	0.578	6.753	13.104	0.142	0.111	0.724	0.724	1.770	0.251	0.989	0.167	ABO. WAT.
397.8	7.5	5	50	0.111	0.856	6.241	12.489	0.136	0.055	0.932	1.069	1.770	0.241	0.983	0.191	NL
395.3	10	7	6	0.058	1.067	8.039	8.106	0.097	0.058	1.073	1.366	1.770	0.172	0.977	0.210	0.819
392.8	12.5	7	6	0.058	1.212	7.743	7.809	0.094	0.058	1.218	1.667	1.770	0.166	0.971	0.225	0.738
390.3	15	6	6	0.057	1.356	6.437	6.497	0.084	0.057	1.362	1.967	1.770	0.149	0.966	0.236	0.631
387.8	17.5	11	6	0.062	1.505	11.484	11.568	0.127	0.062	1.511	2.272	1.770	0.225	0.960	0.244	0.922
385.3	20	6	50	0.057	1.654	6.122	12.346	0.134	0.057	1.660	2.577	1.770	0.237	0.954	0.250	NL
382.8	22.5	6	50	0.057	1.797	6.014	12.217	0.133	0.057	1.803	2.876	1.770	0.235	0.948	0.256	NL
380.3	25	27	6	0.070	1.956	26.547	26.701	0.330	0.070	1.962	3.191	1.770	0.584	0.943	0.259	N60cs>25
377.8	27.5	15	6	0.065	2.125	14.474	14.572	0.156	0.065	2.131	3.516	1.768	0.276	0.937	0.261	1.057
375.3	30	26	6	0.070	2.294	24.273	24.417	0.281	0.070	2.300	3.841	1.741	0.489	0.931	0.263	1.859
372.8	32.5	30	6	0.071	2.470	26.991	27.147	0.343	0.071	2.476	4.173	1.716	0.589	0.911	0.259	N60cs>25
370.3	35	23	6	0.068	2.644	20.001	20.125	0.217	0.068	2.650	4.503	1.693	0.367	0.891	0.256	1.434
367.8	37.5	27	6	0.070	2.817	22.747	22.884	0.255	0.070	2.823	4.832	1.671	0.426	0.870	0.252	1.690
365.3	40	31	6	0.071	2.993	25.337	25.486	0.302	0.071	2.999	5.164	1.651	0.499	0.850	0.247	N60cs>25
362.8	42.5	28	6	0.070	3.169	22.241	22.375	0.247	0.070	3.175	5.496	1.633	0.403	0.830	0.243	1.658
360.3	45	22	6	0.068	3.342	17.016	17.126	0.182	0.068	3.348	5.825	1.615	0.294	0.810	0.238	1.235
357.8	47.5	29	6	0.071	3.516	21.869	22.001	0.242	0.071	3.522	6.155	1.599	0.387	0.789	0.233	1.661
355.3	50	34	6	0.072	3.695	25.010	25.157	0.295	0.072	3.701	6.490	1.583	0.467	0.769	0.228	N60cs>25
352.8	52.5	32	6	0.071	3.874	22.989	23.127	0.259	0.071	3.880	6.825	1.568	0.406	0.749	0.223	1.821
350.3	55	32	6	0.071	4.052	21.823	21.955	0.241	0.071	4.058	7.159	1.554	0.375	0.729	0.217	1.728
347.8	57.5	30	6	0.071	4.230	19.910	20.033	0.216	0.071	4.236	7.493	1.541	0.333	0.708	0.212	1.571
345.3	60	30	6	0.071	4.408	19.389	19.510	0.209	0.071	4.414	7.827	1.529	0.320	0.688	0.206	1.553
342.8	62.5	27	6	0.070	4.584	17.010	17.120	0.182	0.070	4.590	8.159	1.517	0.276	0.668	0.201	1.373
340.3	65	49	6	0.076	4.767	30.082	30.253	1.000	0.076	4.773	8.498	1.505	1.505	0.648	0.195	N60cs>25
337.8	67.5	58	6	0.077	4.958	34.683	34.876	1.000	0.077	4.964	8.845	1.493	1.493	0.627	0.189	N60cs>25
335.3	70	54	6	0.076	5.149	31.474	31.651	1.000	0.076	5.155	9.192	1.482	1.482	0.607	0.183	N60cs>25
332.8	72.5	46	6	0.075	5.338	26.157	26.310	0.320	0.075	5.344	9.537	1.471	0.471	0.587	0.177	N60cs>25
330.3	75	29	6	0.071	5.521	16.109	16.214	0.172	0.071	5.527	9.876	1.461	0.251	0.567	0.171	1.468
327.8	77.5	24	12	0.069	5.696	13.043	15.008	0.160	0.069	5.702	10.207	1.452	0.232	0.546	0.165	1.406
325.3	80	15	12	0.065	5.864	7.986	9.792	0.111	0.065	5.870	10.531	1.444	0.160	0.526	0.159	1.006

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-09 1000 Long period  
 ELEVATION OF BORING GROUND SURFACE ===== 404.80 FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 4.80 FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.100 Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 7.5 Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 0.00 FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)=</b> 1.00
Earthquake Magnitude Scaling Factor <b>(MSF)=</b> 1.000

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
402.3	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	0.420	0.420	1.000	0.139	0.994	0.065	ABO. WAT.
399.8	5	6	50	0.113	0.580	8.104	14.725	0.157	0.057	0.630	0.642	1.000	0.157	0.989	0.066	NL
397.3	7.5	5	50	0.111	0.860	6.227	12.472	0.136	0.055	0.770	0.938	1.000	0.136	0.983	0.078	NL
394.8	10	6	50	0.057	1.070	6.881	13.257	0.143	0.057	0.910	1.234	1.000	0.143	0.977	0.086	NL
392.3	12.5	0	50	0.031	1.180	0.000	5.000	0.072	0.031	1.020	1.500	1.000	0.072	0.971	0.093	NL
389.8	15	4	12	0.054	1.286	4.407	6.100	0.080	0.054	1.126	1.762	1.000	0.080	0.966	0.098	0.816
387.3	17.5	5	12	0.055	1.422	5.370	7.093	0.088	0.055	1.262	2.054	1.000	0.088	0.960	0.102	0.863
384.8	20	8	50	0.059	1.565	8.391	15.069	0.161	0.059	1.405	2.353	1.000	0.161	0.954	0.104	NL
382.3	22.5	4	50	0.054	1.706	4.115	9.938	0.113	0.054	1.546	2.650	1.000	0.113	0.948	0.106	NL
379.8	25	25	5	0.069	1.860	25.207	25.207	0.296	0.069	1.700	2.960	1.000	0.296	0.943	0.107	N60cs>25
377.3	27.5	20	5	0.067	2.030	19.744	19.744	0.212	0.067	1.870	3.286	1.000	0.212	0.937	0.107	1.981
374.8	30	27	5	0.070	2.201	25.734	25.734	0.307	0.070	2.041	3.613	1.000	0.307	0.931	0.107	N60cs>25
372.3	32.5	38	5	0.073	2.380	34.829	34.829	1.000	0.073	2.220	3.948	0.991	0.991	0.911	0.105	N60cs>25
369.8	35	35	5	0.072	2.561	30.925	30.925	1.000	0.072	2.401	4.285	0.975	0.975	0.891	0.103	N60cs>25
367.3	37.5	27	5	0.070	2.739	23.068	23.068	0.258	0.070	2.579	4.619	0.962	0.248	0.870	0.101	2.455
364.8	40	26	5	0.070	2.914	21.537	21.537	0.236	0.070	2.754	4.950	0.949	0.224	0.850	0.099	2.263
362.3	42.5	25	5	0.069	3.088	20.116	20.116	0.217	0.069	2.928	5.280	0.937	0.203	0.830	0.097	2.093
359.8	45	21	5	0.068	3.259	16.449	16.449	0.175	0.068	3.099	5.607	0.927	0.162	0.810	0.095	1.705
357.3	47.5	18	5	0.066	3.427	13.749	13.749	0.148	0.066	3.267	5.931	0.917	0.136	0.789	0.093	1.462
354.8	50	29	5	0.071	3.598	21.618	21.618	0.237	0.071	3.438	6.258	0.908	0.215	0.769	0.091	2.363
352.3	52.5	24	5	0.069	3.773	17.471	17.471	0.186	0.069	3.613	6.589	0.899	0.167	0.749	0.089	1.876
349.8	55	21	5	0.068	3.944	14.952	14.952	0.160	0.068	3.784	6.916	0.891	0.143	0.729	0.087	1.644
347.3	57.5	11	5	0.062	4.107	7.438	7.438	0.091	0.062	3.947	7.235	0.883	0.080	0.708	0.084	0.952
344.8	60	18	5	0.066	4.267	11.879	11.879	0.130	0.066	4.107	7.551	0.876	0.114	0.688	0.082	1.390
342.3	62.5	23	5	0.068	4.435	14.806	14.806	0.158	0.068	4.275	7.875	0.869	0.137	0.668	0.080	1.713
339.8	65	22	5	0.068	4.605	13.819	13.819	0.148	0.068	4.445	8.201	0.862	0.128	0.648	0.078	1.641
337.3	67.5	17	12	0.066	4.773	10.428	12.311	0.134	0.066	4.613	8.525	0.856	0.115	0.627	0.075	1.533
334.8	70	45	5	0.075	4.949	26.942	26.942	0.337	0.075	4.789	8.857	0.850	0.286	0.607	0.073	N60cs>25
332.3	72.5	27	4	0.070	5.130	15.777	15.777	0.168	0.070	4.970	9.194	0.843	0.142	0.587	0.071	2.000
329.8	75	64	4	0.078	5.315	36.500	36.500	1.000	0.078	5.155	9.535	0.837	0.837	0.567	0.068	N60cs>25
327.3	77.5	52	5	0.076	5.508	28.933	28.933	0.407	0.076	5.348	9.884	0.831	0.338	0.546	0.066	N60cs>25
324.8	80	16	12	0.065	5.684	8.709	10.538	0.118	0.065	5.524	10.216	0.826	0.097	0.526	0.063	1.540

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction



# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-09 1000 Short period  
 ELEVATION OF BORING GROUND SURFACE ===== 404.80 FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 4.80 FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.190 Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 5.6 Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 0.00 FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor	<b>(K<math>\alpha</math>)= 1.00</b>
Earthquake Magnitude Scaling Factor	<b>(MSF)= 2.112</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K $\sigma$ )(K $\alpha$ )(MSF)					
402.3	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	0.420	0.420	2.112	0.294	0.994	0.123	ABO. WAT.	
399.8	5	6	50	0.113	0.580	8.104	14.725	0.157	0.057	0.630	0.642	2.112	0.332	0.989	0.124	NL	
397.3	7.5	5	50	0.111	0.860	6.227	12.472	0.136	0.055	0.770	0.938	2.112	0.287	0.983	0.148	NL	
394.8	10	6	50	0.057	1.070	6.881	13.257	0.143	0.057	0.910	1.234	2.112	0.302	0.977	0.164	NL	
392.3	12.5	0	50	0.031	1.180	0.000	5.000	0.072	0.031	1.020	1.500	2.112	0.152	0.971	0.176	NL	
389.8	15	4	12	0.054	1.286	4.407	6.100	0.080	0.054	1.126	1.762	2.112	0.169	0.966	0.187	0.904	
387.3	17.5	5	12	0.055	1.422	5.370	7.093	0.088	0.055	1.262	2.054	2.112	0.186	0.960	0.193	0.964	
384.8	20	8	50	0.059	1.565	8.391	15.069	0.161	0.059	1.405	2.353	2.112	0.340	0.954	0.197	NL	
382.3	22.5	4	50	0.054	1.706	4.115	9.938	0.113	0.054	1.546	2.650	2.112	0.239	0.948	0.201	NL	
379.8	25	25	5	0.069	1.860	25.207	25.207	0.296	0.069	1.700	2.960	2.112	0.625	0.943	0.203	N60cs>25	
377.3	27.5	20	5	0.067	2.030	19.744	19.744	0.212	0.067	1.870	3.286	2.112	0.448	0.937	0.203	2.207	
374.8	30	27	5	0.070	2.201	25.734	25.734	0.307	0.070	2.041	3.613	2.112	0.648	0.931	0.204	N60cs>25	
372.3	32.5	38	5	0.073	2.380	34.829	34.829	1.000	0.073	2.220	3.948	2.093	2.093	0.911	0.200	N60cs>25	
369.8	35	35	5	0.072	2.561	30.925	30.925	1.000	0.072	2.401	4.285	2.060	2.060	0.891	0.196	N60cs>25	
367.3	37.5	27	5	0.070	2.739	23.068	23.068	0.258	0.070	2.579	4.619	2.031	0.524	0.870	0.192	2.729	
364.8	40	26	5	0.070	2.914	21.537	21.537	0.236	0.070	2.754	4.950	2.004	0.473	0.850	0.189	2.503	
362.3	42.5	25	5	0.069	3.088	20.116	20.116	0.217	0.069	2.928	5.280	1.980	0.430	0.830	0.185	2.324	
359.8	45	21	5	0.068	3.259	16.449	16.449	0.175	0.068	3.099	5.607	1.958	0.343	0.810	0.181	1.895	
357.3	47.5	18	5	0.066	3.427	13.749	13.749	0.148	0.066	3.267	5.931	1.937	0.287	0.789	0.177	1.621	
354.8	50	29	5	0.071	3.598	21.618	21.618	0.237	0.071	3.438	6.258	1.917	0.454	0.769	0.173	2.624	
352.3	52.5	24	5	0.069	3.773	17.471	17.471	0.186	0.069	3.613	6.589	1.898	0.353	0.749	0.169	2.089	
349.8	55	21	5	0.068	3.944	14.952	14.952	0.160	0.068	3.784	6.916	1.881	0.301	0.729	0.165	1.824	
347.3	57.5	11	5	0.062	4.107	7.438	7.438	0.091	0.062	3.947	7.235	1.865	0.170	0.708	0.160	1.063	
344.8	60	18	5	0.066	4.267	11.879	11.879	0.130	0.066	4.107	7.551	1.850	0.241	0.688	0.156	1.545	
342.3	62.5	23	5	0.068	4.435	14.806	14.806	0.158	0.068	4.275	7.875	1.836	0.290	0.668	0.152	1.908	
339.8	65	22	5	0.068	4.605	13.819	13.819	0.148	0.068	4.445	8.201	1.821	0.270	0.648	0.148	1.824	
337.3	67.5	17	12	0.066	4.773	10.428	12.311	0.134	0.066	4.613	8.525	1.808	0.242	0.627	0.143	1.692	
334.8	70	45	5	0.075	4.949	26.942	26.942	0.337	0.075	4.789	8.857	1.794	0.605	0.607	0.139	N60cs>25	
332.3	72.5	27	4	0.070	5.130	15.777	15.777	0.168	0.070	4.970	9.194	1.781	0.299	0.587	0.134	2.231	
329.8	75	64	4	0.078	5.315	36.500	36.500	1.000	0.078	5.155	9.535	1.768	1.768	0.567	0.130	N60cs>25	
327.3	77.5	52	5	0.076	5.508	28.933	28.933	0.407	0.076	5.348	9.884	1.755	0.714	0.546	0.125	N60cs>25	
324.8	80	16	12	0.065	5.684	8.709	10.538	0.118	0.065	5.524	10.216	1.744	0.206	0.526	0.120	1.717	

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-09 2500 Long period  
 ELEVATION OF BORING GROUND SURFACE ===== 404.80 FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 4.80 FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.120 Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 7.7 Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 0.00 FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground
Shear Stress
Correct. Factor
<b>(K<math>\alpha</math>)= 1.00</b>
Earthquake
Magnitude
Scaling Factor
<b>(MSF)= 0.935</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K $\sigma$ )(K $\alpha$ )(MSF)				
402.3	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	0.420	0.420	0.935	0.130	0.994	0.078	ABO. WAT.
399.8	5	6	50	0.113	0.580	8.104	14.725	0.157	0.057	0.630	0.642	0.935	0.147	0.989	0.079	NL
397.3	7.5	5	50	0.111	0.860	6.227	12.472	0.136	0.055	0.770	0.938	0.935	0.127	0.983	0.093	NL
394.8	10	6	50	0.057	1.070	6.881	13.257	0.143	0.057	0.910	1.234	0.935	0.134	0.977	0.103	NL
392.3	12.5	0	50	0.031	1.180	0.000	5.000	0.072	0.031	1.020	1.500	0.935	0.067	0.971	0.111	NL
389.8	15	4	12	0.054	1.286	4.407	6.100	0.080	0.054	1.126	1.762	0.935	0.075	0.966	0.118	0.636
387.3	17.5	5	12	0.055	1.422	5.370	7.093	0.088	0.055	1.262	2.054	0.935	0.082	0.960	0.122	0.672
384.8	20	8	50	0.059	1.565	8.391	15.069	0.161	0.059	1.405	2.353	0.935	0.151	0.954	0.125	NL
382.3	22.5	4	50	0.054	1.706	4.115	9.938	0.113	0.054	1.546	2.650	0.935	0.106	0.948	0.127	NL
379.8	25	25	5	0.069	1.860	25.207	25.207	0.296	0.069	1.700	2.960	0.935	0.277	0.943	0.128	N60cs>25
377.3	27.5	20	5	0.067	2.030	19.744	19.744	0.212	0.067	1.870	3.286	0.935	0.198	0.937	0.128	1.547
374.8	30	27	5	0.070	2.201	25.734	25.734	0.307	0.070	2.041	3.613	0.935	0.287	0.931	0.129	N60cs>25
372.3	32.5	38	5	0.073	2.380	34.829	34.829	1.000	0.073	2.220	3.948	0.926	0.926	0.911	0.126	N60cs>25
369.8	35	35	5	0.072	2.561	30.925	30.925	1.000	0.072	2.401	4.285	0.912	0.912	0.891	0.124	N60cs>25
367.3	37.5	27	5	0.070	2.739	23.068	23.068	0.258	0.070	2.579	4.619	0.899	0.232	0.870	0.122	1.902
364.8	40	26	5	0.070	2.914	21.537	21.537	0.236	0.070	2.754	4.950	0.887	0.209	0.850	0.119	1.756
362.3	42.5	25	5	0.069	3.088	20.116	20.116	0.217	0.069	2.928	5.280	0.877	0.190	0.830	0.117	1.624
359.8	45	21	5	0.068	3.259	16.449	16.449	0.175	0.068	3.099	5.607	0.867	0.152	0.810	0.114	1.333
357.3	47.5	18	5	0.066	3.427	13.749	13.749	0.148	0.066	3.267	5.931	0.858	0.127	0.789	0.112	1.134
354.8	50	29	5	0.071	3.598	21.618	21.618	0.237	0.071	3.438	6.258	0.849	0.201	0.769	0.109	1.844
352.3	52.5	24	5	0.069	3.773	17.471	17.471	0.186	0.069	3.613	6.589	0.840	0.156	0.749	0.107	1.458
349.8	55	21	5	0.068	3.944	14.952	14.952	0.160	0.068	3.784	6.916	0.833	0.133	0.729	0.104	1.279
347.3	57.5	11	5	0.062	4.107	7.438	7.438	0.091	0.062	3.947	7.235	0.826	0.075	0.708	0.101	0.743
344.8	60	18	5	0.066	4.267	11.879	11.879	0.130	0.066	4.107	7.551	0.819	0.106	0.688	0.099	1.071
342.3	62.5	23	5	0.068	4.435	14.806	14.806	0.158	0.068	4.275	7.875	0.813	0.128	0.668	0.096	1.333
339.8	65	22	5	0.068	4.605	13.819	13.819	0.148	0.068	4.445	8.201	0.806	0.119	0.648	0.093	1.280
337.3	67.5	17	12	0.066	4.773	10.428	12.311	0.134	0.066	4.613	8.525	0.800	0.107	0.627	0.090	1.189
334.8	70	45	5	0.075	4.949	26.942	26.942	0.337	0.075	4.789	8.857	0.794	0.268	0.607	0.088	N60cs>25
332.3	72.5	27	4	0.070	5.130	15.777	15.777	0.168	0.070	4.970	9.194	0.789	0.133	0.587	0.085	1.565
329.8	75	64	4	0.078	5.315	36.500	36.500	1.000	0.078	5.155	9.535	0.783	0.783	0.567	0.082	N60cs>25
327.3	77.5	52	5	0.076	5.508	28.933	28.933	0.407	0.076	5.348	9.884	0.777	0.316	0.546	0.079	N60cs>25
324.8	80	16	12	0.065	5.684	8.709	10.538	0.118	0.065	5.524	10.216	0.772	0.091	0.526	0.076	1.197

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-09** **2500 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **404.80** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **4.80** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.260** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **6.0** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.770</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> )60	Fines Content Corrected (N <sub>1</sub> )60cs	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
402.3	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	0.420	0.420	1.770	0.246	0.994	0.168	ABO. WAT.
399.8	5	6	50	0.113	0.580	8.104	14.725	0.157	0.057	0.630	0.642	1.770	0.278	0.989	0.170	NL
397.3	7.5	5	50	0.111	0.860	6.227	12.472	0.136	0.055	0.770	0.938	1.770	0.241	0.983	0.202	NL
394.8	10	6	50	0.057	1.070	6.881	13.257	0.143	0.057	0.910	1.234	1.770	0.253	0.977	0.224	NL
392.3	12.5	0	50	0.031	1.180	0.000	5.000	0.072	0.031	1.020	1.500	1.770	0.127	0.971	0.241	NL
389.8	15	4	12	0.054	1.286	4.407	6.100	0.080	0.054	1.126	1.762	1.770	0.142	0.966	0.255	0.557
387.3	17.5	5	12	0.055	1.422	5.370	7.093	0.088	0.055	1.262	2.054	1.770	0.156	0.960	0.264	0.591
384.8	20	8	50	0.059	1.565	8.391	15.069	0.161	0.059	1.405	2.353	1.770	0.285	0.954	0.270	NL
382.3	22.5	4	50	0.054	1.706	4.115	9.938	0.113	0.054	1.546	2.650	1.770	0.200	0.948	0.275	NL
379.8	25	25	5	0.069	1.860	25.207	25.207	0.296	0.069	1.700	2.960	1.770	0.524	0.943	0.277	N60cs>25
377.3	27.5	20	5	0.067	2.030	19.744	19.744	0.212	0.067	1.870	3.286	1.770	0.375	0.937	0.278	1.349
374.8	30	27	5	0.070	2.201	25.734	25.734	0.307	0.070	2.041	3.613	1.770	0.543	0.931	0.279	N60cs>25
372.3	32.5	38	5	0.073	2.380	34.829	34.829	1.000	0.073	2.220	3.948	1.754	1.754	0.911	0.274	N60cs>25
369.8	35	35	5	0.072	2.561	30.925	30.925	1.000	0.072	2.401	4.285	1.726	1.726	0.891	0.269	N60cs>25
367.3	37.5	27	5	0.070	2.739	23.068	23.068	0.258	0.070	2.579	4.619	1.702	0.439	0.870	0.263	1.669
364.8	40	26	5	0.070	2.914	21.537	21.537	0.236	0.070	2.754	4.950	1.680	0.396	0.850	0.258	1.535
362.3	42.5	25	5	0.069	3.088	20.116	20.116	0.217	0.069	2.928	5.280	1.659	0.360	0.830	0.253	1.423
359.8	45	21	5	0.068	3.259	16.449	16.449	0.175	0.068	3.099	5.607	1.641	0.287	0.810	0.248	1.157
357.3	47.5	18	5	0.066	3.427	13.749	13.749	0.148	0.066	3.267	5.931	1.623	0.240	0.789	0.242	0.992
354.8	50	29	5	0.071	3.598	21.618	21.618	0.237	0.071	3.438	6.258	1.607	0.381	0.769	0.237	1.608
352.3	52.5	24	5	0.069	3.773	17.471	17.471	0.186	0.069	3.613	6.589	1.591	0.296	0.749	0.231	1.281
349.8	55	21	5	0.068	3.944	14.952	14.952	0.160	0.068	3.784	6.916	1.576	0.252	0.729	0.225	1.120
347.3	57.5	11	5	0.062	4.107	7.438	7.438	0.091	0.062	3.947	7.235	1.563	0.142	0.708	0.219	0.648
344.8	60	18	5	0.066	4.267	11.879	11.879	0.130	0.066	4.107	7.551	1.551	0.202	0.688	0.214	0.944
342.3	62.5	23	5	0.068	4.435	14.806	14.806	0.158	0.068	4.275	7.875	1.538	0.243	0.668	0.208	1.168
339.8	65	22	5	0.068	4.605	13.819	13.819	0.148	0.068	4.445	8.201	1.526	0.226	0.648	0.202	1.119
337.3	67.5	17	12	0.066	4.773	10.428	12.311	0.134	0.066	4.613	8.525	1.515	0.203	0.627	0.196	1.036
334.8	70	45	5	0.075	4.949	26.942	26.942	0.337	0.075	4.789	8.857	1.504	0.507	0.607	0.190	N60cs>25
332.3	72.5	27	4	0.070	5.130	15.777	15.777	0.168	0.070	4.970	9.194	1.493	0.251	0.587	0.184	1.364
329.8	75	64	4	0.078	5.315	36.500	36.500	1.000	0.078	5.155	9.535	1.482	1.482	0.567	0.177	N60cs>25
327.3	77.5	52	5	0.076	5.508	28.933	28.933	0.407	0.076	5.348	9.884	1.471	0.599	0.546	0.171	N60cs>25
324.8	80	16	12	0.065	5.684	8.709	10.538	0.118	0.065	5.524	10.216	1.461	0.172	0.526	0.164	1.049

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-10** **1000 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **404.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **4.70** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.100** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.5** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.000</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
402.2	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	0.414	0.414	1.000	0.155	0.994	0.065	ABO. WAT.	
399.7	5	5	50	0.111	0.580	6.753	13.104	0.142	0.055	0.624	0.643	1.000	0.142	0.989	0.066	NL	
397.2	7.5	4	50	0.109	0.855	4.996	10.995	0.122	0.054	0.760	0.935	1.000	0.122	0.983	0.079	NL	
394.7	10	5	12	0.055	1.060	5.761	7.496	0.092	0.055	0.896	1.227	1.000	0.092	0.977	0.087	1.057	
392.2	12.5	7	12	0.058	1.201	7.779	9.578	0.109	0.058	1.037	1.524	1.000	0.109	0.971	0.093	1.172	
389.7	15	9	12	0.060	1.349	9.680	11.539	0.127	0.060	1.185	1.828	1.000	0.127	0.966	0.097	1.309	
387.2	17.5	13	5	0.063	1.503	13.581	13.581	0.146	0.063	1.339	2.138	1.000	0.146	0.960	0.100	1.460	
384.7	20	6	50	0.057	1.653	6.124	12.349	0.134	0.057	1.489	2.444	1.000	0.134	0.954	0.102	NL	
382.2	22.5	11	5	0.062	1.802	11.010	11.010	0.122	0.062	1.638	2.749	1.000	0.122	0.948	0.103	1.184	
379.7	25	25	5	0.069	1.966	24.518	24.518	0.283	0.069	1.802	3.069	1.000	0.283	0.943	0.104	2.721	
377.2	27.5	27	5	0.070	2.140	25.961	25.961	0.312	0.070	1.976	3.399	1.000	0.312	0.937	0.105	N60cs>25	
374.7	30	13	5	0.063	2.306	12.105	12.105	0.132	0.063	2.142	3.721	0.998	0.132	0.931	0.105	1.257	
372.2	32.5	23	5	0.068	2.470	20.693	20.693	0.224	0.068	2.306	4.041	0.983	0.220	0.911	0.104	2.115	
369.7	35	23	5	0.068	2.640	20.016	20.016	0.216	0.068	2.476	4.367	0.969	0.209	0.891	0.102	2.049	
367.2	37.5	17	5	0.066	2.808	14.345	14.345	0.154	0.066	2.644	4.691	0.957	0.147	0.870	0.100	1.470	
364.7	40	19	5	0.067	2.974	15.579	15.579	0.166	0.067	2.810	5.013	0.945	0.157	0.850	0.099	1.586	
362.2	42.5	17	5	0.066	3.140	13.565	13.565	0.146	0.066	2.976	5.335	0.934	0.136	0.830	0.097	1.402	
359.7	45	16	5	0.065	3.304	12.447	12.447	0.135	0.065	3.140	5.655	0.924	0.125	0.810	0.095	1.316	
357.2	47.5	18	5	0.066	3.468	13.667	13.667	0.147	0.066	3.304	5.975	0.915	0.135	0.789	0.093	1.452	
354.7	50	27	5	0.070	3.638	20.016	20.016	0.216	0.070	3.474	6.301	0.906	0.196	0.769	0.091	2.154	
352.2	52.5	41	5	0.074	3.818	29.670	29.670	0.446	0.074	3.654	6.637	0.897	0.400	0.749	0.088	N60cs>25	
349.7	55	39	5	0.073	4.002	26.804	26.804	0.333	0.073	3.838	6.977	0.888	0.296	0.729	0.086	N60cs>25	
347.2	57.5	36	5	0.073	4.185	24.055	24.055	0.274	0.073	4.021	7.316	0.880	0.241	0.708	0.084	2.869	
344.7	60	37	5	0.073	4.368	24.054	24.054	0.274	0.073	4.204	7.655	0.872	0.239	0.688	0.081	2.951	
342.2	62.5	31	5	0.071	4.548	19.632	19.632	0.211	0.071	4.384	7.991	0.865	0.183	0.668	0.079	2.316	
339.7	65	42	5	0.074	4.729	25.922	25.922	0.311	0.074	4.565	8.328	0.858	0.267	0.648	0.077	N60cs>25	
337.2	67.5	9	12	0.060	4.897	5.427	7.152	0.089	0.060	4.733	8.652	0.852	0.076	0.627	0.075	1.013	
334.7	70	47	5	0.075	5.066	27.699	27.699	0.359	0.075	4.902	8.977	0.846	0.304	0.607	0.072	N60cs>25	
332.2	72.5	17	5	0.066	5.242	9.788	9.788	0.111	0.066	5.078	9.309	0.840	0.093	0.587	0.070	1.329	
329.7	75	100	5	0.083	5.428	56.208	56.208	1.000	0.083	5.264	9.651	0.834	0.834	0.567	0.068	N60cs>25	
327.2	77.5	47	5	0.075	5.626	25.766	25.766	0.308	0.075	5.462	10.005	0.828	0.255	0.546	0.065	N60cs>25	
324.7	80	17	5	0.066	5.802	9.120	9.120	0.105	0.066	5.638	10.337	0.822	0.086	0.526	0.063	1.365	
322.2	82.5	7	5	0.058	5.957	3.686	3.686	0.063	0.058	5.793	10.648	0.818	0.052	0.506	0.060	0.867	
319.7	85	37	5	0.073	6.121	19.388	19.388	0.208	0.073	5.957	10.968	0.813	0.169	0.486	0.058	2.914	
317.2	87.5	22	5	0.068	6.297	11.528	11.528	0.127	0.068	6.133	11.300	0.809	0.103	0.465	0.056	1.839	
314.7	90	25	5	0.069	6.468	13.100	13.100	0.141	0.069	6.304	11.627	0.804	0.113	0.445	0.053	2.132	
312.2	92.5	36	5	0.073	6.646	18.864	18.864	0.202	0.073	6.482	11.961	0.800	0.162	0.425	0.051	3.176	
309.7	95	100	5	0.083	6.841	52.400	52.400	1.000	0.083	6.677	12.312	0.795	0.795	0.405	0.049	N60cs>25	
307.2	97.5	85	5	0.081	7.046	44.540	44.540	1.000	0.081	6.882	12.673	0.790	0.790	0.384	0.046	N60cs>25	
304.7	100	79	5	0.080	7.247	41.396	41.396	1.000	0.080	7.083	13.030	0.786	0.786	0.364	0.044	N60cs>25	
302.2	102.5	100	5	0.083	7.451	52.400	52.400	1.000	0.083	7.287	13.390	0.781	0.781	0.344	0.041	N60cs>25	
299.7	105	100	5	0.083	7.659	52.400	52.400	1.000	0.083	7.495	13.754	0.777	0.777	0.324	0.039	N60cs>25	

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-10 1000 Short period  
 ELEVATION OF BORING GROUND SURFACE ===== 404.70 FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 4.70 FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.190 Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 5.6 Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 0.00 FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)=</b> 1.00
Earthquake Magnitude Scaling Factor <b>(MSF)=</b> 2.112

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)		Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)				
402.2	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	0.414	0.414	2.112	0.327	0.994	0.123	ABO. WAT.
399.7	5	5	50	0.111	0.580	6.753	13.104	0.142	0.055	0.624	0.643	2.112	0.300	0.989	0.126	NL
397.2	7.5	4	50	0.109	0.855	4.996	10.995	0.122	0.054	0.760	0.935	2.112	0.258	0.983	0.149	NL
394.7	10	5	12	0.055	1.060	5.761	7.496	0.092	0.055	0.896	1.227	2.112	0.194	0.977	0.165	1.176
392.2	12.5	7	12	0.058	1.201	7.779	9.578	0.109	0.058	1.037	1.524	2.112	0.230	0.971	0.176	1.307
389.7	15	9	12	0.060	1.349	9.680	11.539	0.127	0.060	1.185	1.828	2.112	0.268	0.966	0.184	1.457
387.2	17.5	13	5	0.063	1.503	13.581	13.581	0.146	0.063	1.339	2.138	2.112	0.308	0.960	0.189	1.630
384.7	20	6	50	0.057	1.653	6.124	12.349	0.134	0.057	1.489	2.444	2.112	0.283	0.954	0.193	NL
382.2	22.5	11	5	0.062	1.802	11.010	11.010	0.122	0.062	1.638	2.749	2.112	0.258	0.948	0.196	1.316
379.7	25	25	5	0.069	1.966	24.518	24.518	0.283	0.069	1.802	3.069	2.112	0.598	0.943	0.198	3.020
377.2	27.5	27	5	0.070	2.140	25.961	25.961	0.312	0.070	1.976	3.399	2.112	0.659	0.937	0.199	N60cs>25
374.7	30	13	5	0.063	2.306	12.105	12.105	0.132	0.063	2.142	3.721	2.108	0.278	0.931	0.200	1.390
372.2	32.5	23	5	0.068	2.470	20.693	20.693	0.224	0.068	2.306	4.041	2.077	0.465	0.911	0.197	2.360
369.7	35	23	5	0.068	2.640	20.016	20.016	0.216	0.068	2.476	4.367	2.047	0.442	0.891	0.194	2.278
367.2	37.5	17	5	0.066	2.808	14.345	14.345	0.154	0.066	2.644	4.691	2.021	0.311	0.870	0.191	1.628
364.7	40	19	5	0.067	2.974	15.579	15.579	0.166	0.067	2.810	5.013	1.996	0.331	0.850	0.187	1.770
362.2	42.5	17	5	0.066	3.140	13.565	13.565	0.146	0.066	2.976	5.335	1.973	0.288	0.830	0.184	1.565
359.7	45	16	5	0.065	3.304	12.447	12.447	0.135	0.065	3.140	5.655	1.952	0.264	0.810	0.180	1.467
357.2	47.5	18	5	0.066	3.468	13.667	13.667	0.147	0.066	3.304	5.975	1.933	0.284	0.789	0.176	1.614
354.7	50	27	5	0.070	3.638	20.016	20.016	0.216	0.070	3.474	6.301	1.913	0.413	0.769	0.172	2.401
352.2	52.5	41	5	0.074	3.818	29.670	29.670	0.446	0.074	3.654	6.637	1.894	0.845	0.749	0.168	N60cs>25
349.7	55	39	5	0.073	4.002	26.804	26.804	0.333	0.073	3.838	6.977	1.876	0.625	0.729	0.164	N60cs>25
347.2	57.5	36	5	0.073	4.185	24.055	24.055	0.274	0.073	4.021	7.316	1.858	0.509	0.708	0.159	3.201
344.7	60	37	5	0.073	4.368	24.054	24.054	0.274	0.073	4.204	7.655	1.842	0.505	0.688	0.155	3.258
342.2	62.5	31	5	0.071	4.548	19.632	19.632	0.211	0.071	4.384	7.991	1.826	0.385	0.668	0.150	2.567
339.7	65	42	5	0.074	4.729	25.922	25.922	0.311	0.074	4.565	8.328	1.812	0.564	0.648	0.146	N60cs>25
337.2	67.5	9	12	0.060	4.897	5.427	7.152	0.089	0.060	4.733	8.652	1.799	0.160	0.627	0.142	1.127
334.7	70	47	5	0.075	5.066	27.699	27.699	0.359	0.075	4.902	8.977	1.786	0.641	0.607	0.137	N60cs>25
332.2	72.5	17	5	0.066	5.242	9.788	9.788	0.111	0.066	5.078	9.309	1.773	0.197	0.587	0.133	1.481
329.7	75	100	5	0.083	5.428	56.208	56.208	1.000	0.083	5.264	9.651	1.761	1.761	0.567	0.128	N60cs>25
327.2	77.5	47	5	0.075	5.626	25.766	25.766	0.308	0.075	5.462	10.005	1.748	0.538	0.546	0.124	N60cs>25
324.7	80	17	5	0.066	5.802	9.120	9.120	0.105	0.066	5.638	10.337	1.737	0.182	0.526	0.119	1.529
322.2	82.5	7	5	0.058	5.957	3.686	3.686	0.063	0.058	5.793	10.648	1.727	0.109	0.506	0.115	0.948
319.7	85	37	5	0.073	6.121	19.388	19.388	0.208	0.073	5.957	10.968	1.718	0.357	0.486	0.111	3.216
317.2	87.5	22	5	0.068	6.297	11.528	11.528	0.127	0.068	6.133	11.300	1.708	0.217	0.465	0.106	2.047
314.7	90	25	5	0.069	6.468	13.100	13.100	0.141	0.069	6.304	11.627	1.698	0.239	0.445	0.101	2.366
312.2	92.5	36	5	0.073	6.646	18.864	18.864	0.202	0.073	6.482	11.961	1.689	0.341	0.425	0.097	3.515
309.7	95	100	5	0.083	6.841	52.400	52.400	1.000	0.083	6.677	12.312	1.679	1.679	0.405	0.092	N60cs>25
307.2	97.5	85	5	0.081	7.046	44.540	44.540	1.000	0.081	6.882	12.673	1.669	1.669	0.384	0.087	N60cs>25
304.7	100	79	5	0.080	7.247	41.396	41.396	1.000	0.080	7.083	13.030	1.659	1.659	0.364	0.083	N60cs>25
302.2	102.5	100	5	0.083	7.451	52.400	52.400	1.000	0.083	7.287	13.390	1.650	1.650	0.344	0.078	N60cs>25
299.7	105	100	5	0.083	7.659	52.400	52.400	1.000	0.083	7.495	13.754	1.641	1.641	0.324	0.073	N60cs>25

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-10** **2500 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **404.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **4.70** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.120** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.7** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)=</b> 1.00
Earthquake Magnitude Scaling Factor <b>(MSF)=</b> 0.935

Elev. of Sample (Feet)	Boring Data			Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
402.2	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	0.414	0.414	0.935	0.145	0.994	0.078	ABO. WAT.
399.7	5	5	50	0.111	0.580	6.753	13.104	0.142	0.055	0.624	0.643	0.935	0.133	0.989	0.079	NL
397.2	7.5	4	50	0.109	0.855	4.996	10.995	0.122	0.054	0.760	0.935	0.935	0.114	0.983	0.094	NL
394.7	10	5	12	0.055	1.060	5.761	7.496	0.092	0.055	0.896	1.227	0.935	0.086	0.977	0.104	0.827
392.2	12.5	7	12	0.058	1.201	7.779	9.578	0.109	0.058	1.037	1.524	0.935	0.102	0.971	0.111	0.919
389.7	15	9	12	0.060	1.349	9.680	11.539	0.127	0.060	1.185	1.828	0.935	0.119	0.966	0.116	1.026
387.2	17.5	13	5	0.063	1.503	13.581	13.581	0.146	0.063	1.339	2.138	0.935	0.137	0.960	0.120	1.142
384.7	20	6	50	0.057	1.653	6.124	12.349	0.134	0.057	1.489	2.444	0.935	0.125	0.954	0.122	NL
382.2	22.5	11	5	0.062	1.802	11.010	11.010	0.122	0.062	1.638	2.749	0.935	0.114	0.948	0.124	0.919
379.7	25	25	5	0.069	1.966	24.518	24.518	0.283	0.069	1.802	3.069	0.935	0.265	0.943	0.125	2.120
377.2	27.5	27	5	0.070	2.140	25.961	25.961	0.312	0.070	1.976	3.399	0.935	0.292	0.937	0.126	N60cs>25
374.7	30	13	5	0.063	2.306	12.105	12.105	0.132	0.063	2.142	3.721	0.933	0.123	0.931	0.126	0.976
372.2	32.5	23	5	0.068	2.470	20.693	20.693	0.224	0.068	2.306	4.041	0.919	0.206	0.911	0.125	1.648
369.7	35	23	5	0.068	2.640	20.016	20.016	0.216	0.068	2.476	4.367	0.906	0.196	0.891	0.123	1.593
367.2	37.5	17	5	0.066	2.808	14.345	14.345	0.154	0.066	2.644	4.691	0.895	0.138	0.870	0.120	1.150
364.7	40	19	5	0.067	2.974	15.579	15.579	0.166	0.067	2.810	5.013	0.884	0.147	0.850	0.118	1.246
362.2	42.5	17	5	0.066	3.140	13.565	13.565	0.146	0.066	2.976	5.335	0.874	0.128	0.830	0.116	1.103
359.7	45	16	5	0.065	3.304	12.447	12.447	0.135	0.065	3.140	5.655	0.864	0.117	0.810	0.114	1.026
357.2	47.5	18	5	0.066	3.468	13.667	13.667	0.147	0.066	3.304	5.975	0.856	0.126	0.789	0.111	1.135
354.7	50	27	5	0.070	3.638	20.016	20.016	0.216	0.070	3.474	6.301	0.847	0.183	0.769	0.109	1.679
352.2	52.5	41	5	0.074	3.818	29.670	29.670	0.446	0.074	3.654	6.637	0.839	0.374	0.749	0.106	N60cs>25
349.7	55	39	5	0.073	4.002	26.804	26.804	0.333	0.073	3.838	6.977	0.830	0.276	0.729	0.103	N60cs>25
347.2	57.5	36	5	0.073	4.185	24.055	24.055	0.274	0.073	4.021	7.316	0.823	0.226	0.708	0.100	2.260
344.7	60	37	5	0.073	4.368	24.054	24.054	0.274	0.073	4.204	7.655	0.815	0.223	0.688	0.098	2.276
342.2	62.5	31	5	0.071	4.548	19.632	19.632	0.211	0.071	4.384	7.991	0.809	0.171	0.668	0.095	1.800
339.7	65	42	5	0.074	4.729	25.922	25.922	0.311	0.074	4.565	8.328	0.802	0.249	0.648	0.092	N60cs>25
337.2	67.5	9	12	0.060	4.897	5.427	7.152	0.089	0.060	4.733	8.652	0.796	0.071	0.627	0.089	0.798
334.7	70	47	5	0.075	5.066	27.699	27.699	0.359	0.075	4.902	8.977	0.791	0.284	0.607	0.087	N60cs>25
332.2	72.5	17	5	0.066	5.242	9.788	9.788	0.111	0.066	5.078	9.309	0.785	0.087	0.587	0.084	1.036
329.7	75	100	5	0.083	5.428	56.208	56.208	1.000	0.083	5.264	9.651	0.779	0.779	0.567	0.081	N60cs>25
327.2	77.5	47	5	0.075	5.626	25.766	25.766	0.308	0.075	5.462	10.005	0.774	0.238	0.546	0.078	N60cs>25
324.7	80	17	5	0.066	5.802	9.120	9.120	0.105	0.066	5.638	10.337	0.769	0.081	0.526	0.075	1.080
322.2	82.5	7	5	0.058	5.957	3.686	3.686	0.063	0.058	5.793	10.648	0.765	0.048	0.506	0.073	0.658
319.7	85	37	5	0.073	6.121	19.388	19.388	0.208	0.073	5.957	10.968	0.760	0.158	0.486	0.070	2.257
317.2	87.5	22	5	0.068	6.297	11.528	11.528	0.127	0.068	6.133	11.300	0.756	0.096	0.465	0.067	1.433
314.7	90	25	5	0.069	6.468	13.100	13.100	0.141	0.069	6.304	11.627	0.752	0.106	0.445	0.064	1.656
312.2	92.5	36	5	0.073	6.646	18.864	18.864	0.202	0.073	6.482	11.961	0.748	0.151	0.425	0.061	2.475
309.7	95	100	5	0.083	6.841	52.400	52.400	1.000	0.083	6.677	12.312	0.743	0.743	0.405	0.058	N60cs>25
307.2	97.5	85	5	0.081	7.046	44.540	44.540	1.000	0.081	6.882	12.673	0.739	0.739	0.384	0.055	N60cs>25
304.7	100	79	5	0.080	7.247	41.396	41.396	1.000	0.080	7.083	13.030	0.735	0.735	0.364	0.052	N60cs>25
302.2	102.5	100	5	0.083	7.451	52.400	52.400	1.000	0.083	7.287	13.390	0.730	0.730	0.344	0.049	N60cs>25
299.7	105	100	5	0.083	7.659	52.400	52.400	1.000	0.083	7.495	13.754	0.726	0.726	0.324	0.046	N60cs>25

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-10 2500 Short period  
 ELEVATION OF BORING GROUND SURFACE ===== 404.70 FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 4.70 FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.260 Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 6.0 Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 0.00 FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)=</b> 1.00
Earthquake Magnitude Scaling Factor <b>(MSF)=</b> 1.770

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)		Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
402.2	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	0.414	0.414	1.770	0.274	0.994	0.168	ABO. WAT.	
399.7	5	5	50	0.111	0.580	6.753	13.104	0.142	0.055	0.624	0.643	1.770	0.251	0.989	0.172	NL	
397.2	7.5	4	50	0.109	0.855	4.996	10.995	0.122	0.054	0.760	0.935	1.770	0.216	0.983	0.204	NL	
394.7	10	5	12	0.055	1.060	5.761	7.496	0.092	0.055	0.896	1.227	1.770	0.163	0.977	0.226	0.721	
392.2	12.5	7	12	0.058	1.201	7.779	9.578	0.109	0.058	1.037	1.524	1.770	0.193	0.971	0.241	0.801	
389.7	15	9	12	0.060	1.349	9.680	11.539	0.127	0.060	1.185	1.828	1.770	0.225	0.966	0.252	0.893	
387.2	17.5	13	5	0.063	1.503	13.581	13.581	0.146	0.063	1.339	2.138	1.770	0.258	0.960	0.259	0.996	
384.7	20	6	50	0.057	1.653	6.124	12.349	0.134	0.057	1.489	2.444	1.770	0.237	0.954	0.265	NL	
382.2	22.5	11	5	0.062	1.802	11.010	11.010	0.122	0.062	1.638	2.749	1.770	0.216	0.948	0.269	0.803	
379.7	25	25	5	0.069	1.966	24.518	24.518	0.283	0.069	1.802	3.069	1.770	0.501	0.943	0.271	1.849	
377.2	27.5	27	5	0.070	2.140	25.961	25.961	0.312	0.070	1.976	3.399	1.770	0.552	0.937	0.272	N60cs>25	
374.7	30	13	5	0.063	2.306	12.105	12.105	0.132	0.063	2.142	3.721	1.766	0.233	0.931	0.273	0.853	
372.2	32.5	23	5	0.068	2.470	20.693	20.693	0.224	0.068	2.306	4.041	1.740	0.390	0.911	0.270	1.444	
369.7	35	23	5	0.068	2.640	20.016	20.016	0.216	0.068	2.476	4.367	1.716	0.371	0.891	0.266	1.395	
367.2	37.5	17	5	0.066	2.808	14.345	14.345	0.154	0.066	2.644	4.691	1.694	0.261	0.870	0.261	1.000	
364.7	40	19	5	0.067	2.974	15.579	15.579	0.166	0.067	2.810	5.013	1.673	0.278	0.850	0.256	1.086	
362.2	42.5	17	5	0.066	3.140	13.565	13.565	0.146	0.066	2.976	5.335	1.654	0.241	0.830	0.251	0.960	
359.7	45	16	5	0.065	3.304	12.447	12.447	0.135	0.065	3.140	5.655	1.636	0.221	0.810	0.247	0.895	
357.2	47.5	18	5	0.066	3.468	13.667	13.667	0.147	0.066	3.304	5.975	1.620	0.238	0.789	0.241	0.988	
354.7	50	27	5	0.070	3.638	20.016	20.016	0.216	0.070	3.474	6.301	1.604	0.346	0.769	0.236	1.466	
352.2	52.5	41	5	0.074	3.818	29.670	29.670	0.446	0.074	3.654	6.637	1.587	0.708	0.749	0.230	N60cs>25	
349.7	55	39	5	0.073	4.002	26.804	26.804	0.333	0.073	3.838	6.977	1.572	0.523	0.729	0.224	N60cs>25	
347.2	57.5	36	5	0.073	4.185	24.055	24.055	0.274	0.073	4.021	7.316	1.557	0.427	0.708	0.218	1.959	
344.7	60	37	5	0.073	4.368	24.054	24.054	0.274	0.073	4.204	7.655	1.544	0.423	0.688	0.212	1.995	
342.2	62.5	31	5	0.071	4.548	19.632	19.632	0.211	0.071	4.384	7.991	1.531	0.323	0.668	0.206	1.568	
339.7	65	42	5	0.074	4.729	25.922	25.922	0.311	0.074	4.565	8.328	1.518	0.472	0.648	0.200	N60cs>25	
337.2	67.5	9	12	0.060	4.897	5.427	7.152	0.089	0.060	4.733	8.652	1.507	0.134	0.627	0.194	0.691	
334.7	70	47	5	0.075	5.066	27.699	27.699	0.359	0.075	4.902	8.977	1.497	0.537	0.607	0.188	N60cs>25	
332.2	72.5	17	5	0.066	5.242	9.788	9.788	0.111	0.066	5.078	9.309	1.486	0.165	0.587	0.182	0.907	
329.7	75	100	5	0.083	5.428	56.208	56.208	1.000	0.083	5.264	9.651	1.476	1.476	0.567	0.176	N60cs>25	
327.2	77.5	47	5	0.075	5.626	25.766	25.766	0.308	0.075	5.462	10.005	1.465	0.451	0.546	0.169	N60cs>25	
324.7	80	17	5	0.066	5.802	9.120	9.120	0.105	0.066	5.638	10.337	1.456	0.153	0.526	0.163	0.939	
322.2	82.5	7	5	0.058	5.957	3.686	3.686	0.063	0.058	5.793	10.648	1.448	0.091	0.506	0.157	0.580	
319.7	85	37	5	0.073	6.121	19.388	19.388	0.208	0.073	5.957	10.968	1.440	0.300	0.486	0.151	1.987	
317.2	87.5	22	5	0.068	6.297	11.528	11.528	0.127	0.068	6.133	11.300	1.431	0.182	0.465	0.145	1.255	
314.7	90	25	5	0.069	6.468	13.100	13.100	0.141	0.069	6.304	11.627	1.423	0.201	0.445	0.139	1.446	
312.2	92.5	36	5	0.073	6.646	18.864	18.864	0.202	0.073	6.482	11.961	1.415	0.286	0.425	0.133	2.150	
309.7	95	100	5	0.083	6.841	52.400	52.400	1.000	0.083	6.677	12.312	1.407	1.407	0.405	0.126	N60cs>25	
307.2	97.5	85	5	0.081	7.046	44.540	44.540	1.000	0.081	6.882	12.673	1.399	1.399	0.384	0.120	N60cs>25	
304.7	100	79	5	0.080	7.247	41.396	41.396	1.000	0.080	7.083	13.030	1.391	1.391	0.364	0.113	N60cs>25	
302.2	102.5	100	5	0.083	7.451	52.400	52.400	1.000	0.083	7.287	13.390	1.383	1.383	0.344	0.107	N60cs>25	
299.7	105	100	5	0.083	7.659	52.400	52.400	1.000	0.083	7.495	13.754	1.375	1.375	0.324	0.100	N60cs>25	

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-11** **1000 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.40** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.40** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.100** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.5** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.000</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
402.9	2.5	4	50	0.109	0.300	5.251	11.301	0.125	0.109	0.451	0.451	1.000	<b>0.125</b>	0.994	<b>0.065</b>	<b>ABO. WAT.</b>	
400.4	5	6	50	0.113	0.578	8.104	14.725	0.157	0.113	0.729	0.729	1.000	<b>0.157</b>	0.989	<b>0.064</b>	<b>ABO. WAT.</b>	
397.9	7.5	4	50	0.109	0.856	4.993	10.992	0.122	0.054	0.938	1.069	1.000	<b>0.122</b>	0.983	<b>0.073</b>	NL	
395.4	10	4	50	0.054	1.060	4.609	10.531	0.118	0.054	1.073	1.360	1.000	<b>0.118</b>	0.977	<b>0.080</b>	NL	
392.9	12.5	8	12	0.059	1.201	8.890	10.724	0.120	0.059	1.214	1.657	1.000	<b>0.120</b>	0.971	<b>0.086</b>	<b>1.395</b>	
390.4	15	7	12	0.058	1.347	7.535	9.326	0.107	0.058	1.360	1.959	1.000	<b>0.107</b>	0.966	<b>0.090</b>	<b>1.189</b>	
387.9	17.5	11	12	0.062	1.497	11.514	13.431	0.145	0.062	1.510	2.265	1.000	<b>0.145</b>	0.960	<b>0.094</b>	<b>1.543</b>	
385.4	20	5	40	0.055	1.643	5.119	11.143	0.123	0.055	1.656	2.567	1.000	<b>0.123</b>	0.954	<b>0.096</b>	<b>1.281</b>	
382.9	22.5	20	50	0.067	1.796	20.052	29.062	0.413	0.067	1.809	2.876	1.000	<b>0.413</b>	0.948	<b>0.098</b>	<b>N60cs&gt;25</b>	
380.4	25	23	6	0.068	1.965	22.562	22.698	0.252	0.068	1.978	3.201	1.000	<b>0.252</b>	0.943	<b>0.099</b>	<b>2.545</b>	
377.9	27.5	11	6	0.062	2.128	10.606	10.685	0.119	0.062	2.141	3.520	0.998	<b>0.119</b>	0.937	<b>0.100</b>	<b>1.190</b>	
375.4	30	15	6	0.065	2.287	14.025	14.121	0.151	0.065	2.300	3.835	0.984	<b>0.149</b>	0.931	<b>0.101</b>	<b>1.475</b>	
372.9	32.5	15	6	0.065	2.450	13.551	13.644	0.147	0.065	2.463	4.154	0.970	<b>0.143</b>	0.911	<b>0.100</b>	<b>1.430</b>	
370.4	35	21	6	0.068	2.616	18.359	18.475	0.197	0.068	2.629	4.476	0.958	<b>0.189</b>	0.891	<b>0.099</b>	<b>1.909</b>	
367.9	37.5	28	6	0.070	2.789	23.707	23.848	0.271	0.070	2.802	4.805	0.946	<b>0.256</b>	0.870	<b>0.097</b>	<b>2.639</b>	
365.4	40	22	6	0.068	2.962	18.075	18.190	0.194	0.068	2.975	5.134	0.934	<b>0.181</b>	0.850	<b>0.095</b>	<b>1.905</b>	
362.9	42.5	26	6	0.070	3.135	20.764	20.891	0.227	0.070	3.148	5.463	0.924	<b>0.210</b>	0.830	<b>0.094</b>	<b>2.234</b>	
360.4	45	24	6	0.069	3.309	18.656	18.773	0.201	0.069	3.322	5.793	0.914	<b>0.184</b>	0.810	<b>0.092</b>	<b>2.000</b>	
357.9	47.5	24	6	0.069	3.482	18.186	18.301	0.195	0.069	3.495	6.122	0.905	<b>0.176</b>	0.789	<b>0.090</b>	<b>1.956</b>	
355.4	50	11	6	0.062	3.646	8.146	8.214	0.098	0.062	3.659	6.442	0.897	<b>0.088</b>	0.769	<b>0.088</b>	<b>1.000</b>	
352.9	52.5	11	6	0.062	3.801	7.978	8.045	0.096	0.062	3.814	6.753	0.889	<b>0.085</b>	0.749	<b>0.086</b>	<b>0.988</b>	
350.4	55	16	6	0.065	3.960	11.369	11.452	0.126	0.065	3.973	7.068	0.882	<b>0.111</b>	0.729	<b>0.084</b>	<b>1.321</b>	
347.9	57.5	32	6	0.071	4.130	21.562	21.693	0.238	0.071	4.143	7.394	0.875	<b>0.208</b>	0.708	<b>0.082</b>	<b>2.537</b>	
345.4	60	25	6	0.069	4.305	16.406	16.513	0.176	0.069	4.318	7.725	0.867	<b>0.153</b>	0.688	<b>0.080</b>	<b>1.913</b>	
342.9	62.5	36	6	0.073	4.483	23.013	23.151	0.259	0.073	4.496	8.059	0.860	<b>0.223</b>	0.668	<b>0.078</b>	<b>2.859</b>	
340.4	65	34	6	0.072	4.664	21.178	21.307	0.232	0.072	4.677	8.396	0.854	<b>0.198</b>	0.648	<b>0.076</b>	<b>2.605</b>	
337.9	67.5	28	12	0.070	4.842	17.012	19.103	0.205	0.070	4.855	8.730	0.847	<b>0.174</b>	0.627	<b>0.073</b>	<b>2.384</b>	
335.4	70	25	12	0.069	5.016	14.833	16.855	0.179	0.069	5.029	9.060	0.841	<b>0.151</b>	0.607	<b>0.071</b>	<b>2.127</b>	
332.9	72.5	83	12	0.081	5.204	48.027	51.097	1.000	0.081	5.217	9.404	0.835	<b>0.835</b>	0.587	<b>0.069</b>	<b>N60cs&gt;25</b>	
330.4	75	40	12	0.074	5.398	22.570	24.836	0.289	0.074	5.411	9.754	0.829	<b>0.240</b>	0.567	<b>0.066</b>	<b>3.636</b>	
327.9	77.5	21	12	0.068	5.576	11.585	13.504	0.145	0.068	5.589	10.088	0.824	<b>0.119</b>	0.546	<b>0.064</b>	<b>1.859</b>	
325.4	80	13	6	0.063	5.740	7.027	7.090	0.088	0.063	5.753	10.408	0.819	<b>0.072</b>	0.526	<b>0.062</b>	<b>1.161</b>	

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction



# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-11** **1000 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.40** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.40** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.190** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **5.6** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 2.112</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
402.9	2.5	4	50	0.109	0.300	5.251	11.301	0.125	0.109	0.451	0.451	2.112	<b>0.264</b>	0.994	<b>0.123</b>	<b>ABO. WAT.</b>	
400.4	5	6	50	0.113	0.578	8.104	14.725	0.157	0.113	0.729	0.729	2.112	<b>0.332</b>	0.989	<b>0.122</b>	<b>ABO. WAT.</b>	
397.9	7.5	4	50	0.109	0.856	4.993	10.992	0.122	0.054	0.938	1.069	2.112	<b>0.258</b>	0.983	<b>0.138</b>	NL	
395.4	10	4	50	0.054	1.060	4.609	10.531	0.118	0.054	1.073	1.360	2.112	<b>0.249</b>	0.977	<b>0.153</b>	NL	
392.9	12.5	8	12	0.059	1.201	8.890	10.724	0.120	0.059	1.214	1.657	2.112	<b>0.253</b>	0.971	<b>0.164</b>	<b>1.543</b>	
390.4	15	7	12	0.058	1.347	7.535	9.326	0.107	0.058	1.360	1.959	2.112	<b>0.226</b>	0.966	<b>0.172</b>	<b>1.314</b>	
387.9	17.5	11	12	0.062	1.497	11.514	13.431	0.145	0.062	1.510	2.265	2.112	<b>0.306</b>	0.960	<b>0.178</b>	<b>1.719</b>	
385.4	20	5	40	0.055	1.643	5.119	11.143	0.123	0.055	1.656	2.567	2.112	<b>0.260</b>	0.954	<b>0.183</b>	<b>1.421</b>	
382.9	22.5	20	50	0.067	1.796	20.052	29.062	0.413	0.067	1.809	2.876	2.112	<b>0.872</b>	0.948	<b>0.186</b>	<b>N60cs&gt;25</b>	
380.4	25	23	6	0.068	1.965	22.562	22.698	0.252	0.068	1.978	3.201	2.112	<b>0.532</b>	0.943	<b>0.188</b>	<b>2.830</b>	
377.9	27.5	11	6	0.062	2.128	10.606	10.685	0.119	0.062	2.141	3.520	2.108	<b>0.251</b>	0.937	<b>0.190</b>	<b>1.321</b>	
375.4	30	15	6	0.065	2.287	14.025	14.121	0.151	0.065	2.300	3.835	2.078	<b>0.314</b>	0.931	<b>0.192</b>	<b>1.635</b>	
372.9	32.5	15	6	0.065	2.450	13.551	13.644	0.147	0.065	2.463	4.154	2.050	<b>0.301</b>	0.911	<b>0.190</b>	<b>1.584</b>	
370.4	35	21	6	0.068	2.616	18.359	18.475	0.197	0.068	2.629	4.476	2.023	<b>0.399</b>	0.891	<b>0.187</b>	<b>2.134</b>	
367.9	37.5	28	6	0.070	2.789	23.707	23.848	0.271	0.070	2.802	4.805	1.997	<b>0.541</b>	0.870	<b>0.184</b>	<b>2.940</b>	
365.4	40	22	6	0.068	2.962	18.075	18.190	0.194	0.068	2.975	5.134	1.974	<b>0.383</b>	0.850	<b>0.181</b>	<b>2.116</b>	
362.9	42.5	26	6	0.070	3.135	20.764	20.891	0.227	0.070	3.148	5.463	1.951	<b>0.443</b>	0.830	<b>0.178</b>	<b>2.489</b>	
360.4	45	24	6	0.069	3.309	18.656	18.773	0.201	0.069	3.322	5.793	1.931	<b>0.388</b>	0.810	<b>0.174</b>	<b>2.230</b>	
357.9	47.5	24	6	0.069	3.482	18.186	18.301	0.195	0.069	3.495	6.122	1.911	<b>0.373</b>	0.789	<b>0.171</b>	<b>2.181</b>	
355.4	50	11	6	0.062	3.646	8.146	8.214	0.098	0.062	3.659	6.442	1.894	<b>0.186</b>	0.769	<b>0.167</b>	<b>1.114</b>	
352.9	52.5	11	6	0.062	3.801	7.978	8.045	0.096	0.062	3.814	6.753	1.878	<b>0.180</b>	0.749	<b>0.164</b>	<b>1.098</b>	
350.4	55	16	6	0.065	3.960	11.369	11.452	0.126	0.065	3.973	7.068	1.863	<b>0.235</b>	0.729	<b>0.160</b>	<b>1.469</b>	
347.9	57.5	32	6	0.071	4.130	21.562	21.693	0.238	0.071	4.143	7.394	1.847	<b>0.440</b>	0.708	<b>0.156</b>	<b>2.821</b>	
345.4	60	25	6	0.069	4.305	16.406	16.513	0.176	0.069	4.318	7.725	1.832	<b>0.322</b>	0.688	<b>0.152</b>	<b>2.118</b>	
342.9	62.5	36	6	0.073	4.483	23.013	23.151	0.259	0.073	4.496	8.059	1.817	<b>0.471</b>	0.668	<b>0.148</b>	<b>3.182</b>	
340.4	65	34	6	0.072	4.664	21.178	21.307	0.232	0.072	4.677	8.396	1.803	<b>0.418</b>	0.648	<b>0.144</b>	<b>2.903</b>	
337.9	67.5	28	12	0.070	4.842	17.012	19.103	0.205	0.070	4.855	8.730	1.789	<b>0.367</b>	0.627	<b>0.139</b>	<b>2.640</b>	
335.4	70	25	12	0.069	5.016	14.833	16.855	0.179	0.069	5.029	9.060	1.777	<b>0.318</b>	0.607	<b>0.135</b>	<b>2.356</b>	
332.9	72.5	83	12	0.081	5.204	48.027	51.097	1.000	0.081	5.217	9.404	1.764	<b>1.764</b>	0.587	<b>0.131</b>	<b>N60cs&gt;25</b>	
330.4	75	40	12	0.074	5.398	22.570	24.836	0.289	0.074	5.411	9.754	1.751	<b>0.506</b>	0.567	<b>0.126</b>	<b>4.016</b>	
327.9	77.5	21	12	0.068	5.576	11.585	13.504	0.145	0.068	5.589	10.088	1.740	<b>0.252</b>	0.546	<b>0.122</b>	<b>2.066</b>	
325.4	80	13	6	0.063	5.740	7.027	7.090	0.088	0.063	5.753	10.408	1.730	<b>0.152</b>	0.526	<b>0.118</b>	<b>1.288</b>	

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-11 2500 Long period  
 ELEVATION OF BORING GROUND SURFACE ===== 405.40 FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 5.40 FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.120 Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 7.7 Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 0.00 FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)=</b> 1.00
Earthquake Magnitude Scaling Factor <b>(MSF)=</b> 0.935

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
402.9	2.5	4	50	0.109	0.300	5.251	11.301	0.125	0.109	0.451	0.451	0.935	0.117	0.994	0.078	ABO. WAT.	
400.4	5	6	50	0.113	0.578	8.104	14.725	0.157	0.113	0.729	0.729	0.935	0.147	0.989	0.077	ABO. WAT.	
397.9	7.5	4	50	0.109	0.856	4.993	10.992	0.122	0.054	0.938	1.069	0.935	0.114	0.983	0.087	NL	
395.4	10	4	50	0.054	1.060	4.609	10.531	0.118	0.054	1.073	1.360	0.935	0.110	0.977	0.097	NL	
392.9	12.5	8	12	0.059	1.201	8.890	10.724	0.120	0.059	1.214	1.657	0.935	0.112	0.971	0.103	1.087	
390.4	15	7	12	0.058	1.347	7.535	9.326	0.107	0.058	1.360	1.959	0.935	0.100	0.966	0.109	0.917	
387.9	17.5	11	12	0.062	1.497	11.514	13.431	0.145	0.062	1.510	2.265	0.935	0.136	0.960	0.112	1.214	
385.4	20	5	40	0.055	1.643	5.119	11.143	0.123	0.055	1.656	2.567	0.935	0.115	0.954	0.115	1.000	
382.9	22.5	20	50	0.067	1.796	20.052	29.062	0.413	0.067	1.809	2.876	0.935	0.386	0.948	0.118	N60cs>25	
380.4	25	23	6	0.068	1.965	22.562	22.698	0.252	0.068	1.978	3.201	0.935	0.236	0.943	0.119	1.983	
377.9	27.5	11	6	0.062	2.128	10.606	10.685	0.119	0.062	2.141	3.520	0.933	0.111	0.937	0.120	0.925	
375.4	30	15	6	0.065	2.287	14.025	14.121	0.151	0.065	2.300	3.835	0.920	0.139	0.931	0.121	1.149	
372.9	32.5	15	6	0.065	2.450	13.551	13.644	0.147	0.065	2.463	4.154	0.907	0.133	0.911	0.120	1.108	
370.4	35	21	6	0.068	2.616	18.359	18.475	0.197	0.068	2.629	4.476	0.896	0.177	0.891	0.118	1.500	
367.9	37.5	28	6	0.070	2.789	23.707	23.848	0.271	0.070	2.802	4.805	0.884	0.240	0.870	0.116	2.069	
365.4	40	22	6	0.068	2.962	18.075	18.190	0.194	0.068	2.975	5.134	0.874	0.170	0.850	0.114	1.491	
362.9	42.5	26	6	0.070	3.135	20.764	20.891	0.227	0.070	3.148	5.463	0.864	0.196	0.830	0.112	1.750	
360.4	45	24	6	0.069	3.309	18.656	18.773	0.201	0.069	3.322	5.793	0.855	0.172	0.810	0.110	1.564	
357.9	47.5	24	6	0.069	3.482	18.186	18.301	0.195	0.069	3.495	6.122	0.846	0.165	0.789	0.108	1.528	
355.4	50	11	6	0.062	3.646	8.146	8.214	0.098	0.062	3.659	6.442	0.838	0.082	0.769	0.106	0.774	
352.9	52.5	11	6	0.062	3.801	7.978	8.045	0.096	0.062	3.814	6.753	0.831	0.080	0.749	0.103	0.777	
350.4	55	16	6	0.065	3.960	11.369	11.452	0.126	0.065	3.973	7.068	0.825	0.104	0.729	0.101	1.030	
347.9	57.5	32	6	0.071	4.130	21.562	21.693	0.238	0.071	4.143	7.394	0.818	0.195	0.708	0.099	1.970	
345.4	60	25	6	0.069	4.305	16.406	16.513	0.176	0.069	4.318	7.725	0.811	0.143	0.688	0.096	1.490	
342.9	62.5	36	6	0.073	4.483	23.013	23.151	0.259	0.073	4.496	8.059	0.804	0.208	0.668	0.093	2.237	
340.4	65	34	6	0.072	4.664	21.178	21.307	0.232	0.072	4.677	8.396	0.798	0.185	0.648	0.091	2.033	
337.9	67.5	28	12	0.070	4.842	17.012	19.103	0.205	0.070	4.855	8.730	0.792	0.162	0.627	0.088	1.841	
335.4	70	25	12	0.069	5.016	14.833	16.855	0.179	0.069	5.029	9.060	0.787	0.141	0.607	0.085	1.659	
332.9	72.5	83	12	0.081	5.204	48.027	51.097	1.000	0.081	5.217	9.404	0.781	0.781	0.587	0.083	N60cs>25	
330.4	75	40	12	0.074	5.398	22.570	24.836	0.289	0.074	5.411	9.754	0.775	0.224	0.567	0.080	2.800	
327.9	77.5	21	12	0.068	5.576	11.585	13.504	0.145	0.068	5.589	10.088	0.770	0.112	0.546	0.077	1.455	
325.4	80	13	6	0.063	5.740	7.027	7.090	0.088	0.063	5.753	10.408	0.766	0.067	0.526	0.074	0.905	

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-11** **2500 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.40** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **5.40** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.260** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **6.0** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.770</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
402.9	2.5	4	50	0.109	0.300	5.251	11.301	0.125	0.109	0.451	0.451	1.770	0.221	0.994	0.168	ABO. WAT.	
400.4	5	6	50	0.113	0.578	8.104	14.725	0.157	0.113	0.729	0.729	1.770	0.278	0.989	0.167	ABO. WAT.	
397.9	7.5	4	50	0.109	0.856	4.993	10.992	0.122	0.054	0.938	1.069	1.770	0.216	0.983	0.189	NL	
395.4	10	4	50	0.054	1.060	4.609	10.531	0.118	0.054	1.073	1.360	1.770	0.209	0.977	0.209	NL	
392.9	12.5	8	12	0.059	1.201	8.890	10.724	0.120	0.059	1.214	1.657	1.770	0.212	0.971	0.224	0.946	
390.4	15	7	12	0.058	1.347	7.535	9.326	0.107	0.058	1.360	1.959	1.770	0.189	0.966	0.235	0.804	
387.9	17.5	11	12	0.062	1.497	11.514	13.431	0.145	0.062	1.510	2.265	1.770	0.257	0.960	0.243	1.058	
385.4	20	5	40	0.055	1.643	5.119	11.143	0.123	0.055	1.656	2.567	1.770	0.218	0.954	0.250	0.872	
382.9	22.5	20	50	0.067	1.796	20.052	29.062	0.413	0.067	1.809	2.876	1.770	0.731	0.948	0.255	N60cs>25	
380.4	25	23	6	0.068	1.965	22.562	22.698	0.252	0.068	1.978	3.201	1.770	0.446	0.943	0.258	1.729	
377.9	27.5	11	6	0.062	2.128	10.606	10.685	0.119	0.062	2.141	3.520	1.767	0.210	0.937	0.260	0.808	
375.4	30	15	6	0.065	2.287	14.025	14.121	0.151	0.065	2.300	3.835	1.741	0.263	0.931	0.262	1.004	
372.9	32.5	15	6	0.065	2.450	13.551	13.644	0.147	0.065	2.463	4.154	1.718	0.253	0.911	0.260	0.973	
370.4	35	21	6	0.068	2.616	18.359	18.475	0.197	0.068	2.629	4.476	1.695	0.334	0.891	0.256	1.305	
367.9	37.5	28	6	0.070	2.789	23.707	23.848	0.271	0.070	2.802	4.805	1.674	0.454	0.870	0.252	1.802	
365.4	40	22	6	0.068	2.962	18.075	18.190	0.194	0.068	2.975	5.134	1.654	0.321	0.850	0.248	1.294	
362.9	42.5	26	6	0.070	3.135	20.764	20.891	0.227	0.070	3.148	5.463	1.635	0.371	0.830	0.243	1.527	
360.4	45	24	6	0.069	3.309	18.656	18.773	0.201	0.069	3.322	5.793	1.618	0.325	0.810	0.239	1.360	
357.9	47.5	24	6	0.069	3.482	18.186	18.301	0.195	0.069	3.495	6.122	1.602	0.312	0.789	0.234	1.333	
355.4	50	11	6	0.062	3.646	8.146	8.214	0.098	0.062	3.659	6.442	1.587	0.156	0.769	0.229	0.681	
352.9	52.5	11	6	0.062	3.801	7.978	8.045	0.096	0.062	3.814	6.753	1.574	0.151	0.749	0.224	0.674	
350.4	55	16	6	0.065	3.960	11.369	11.452	0.126	0.065	3.973	7.068	1.561	0.197	0.729	0.219	0.900	
347.9	57.5	32	6	0.071	4.130	21.562	21.693	0.238	0.071	4.143	7.394	1.548	0.368	0.708	0.214	1.720	
345.4	60	25	6	0.069	4.305	16.406	16.513	0.176	0.069	4.318	7.725	1.535	0.270	0.688	0.208	1.298	
342.9	62.5	36	6	0.073	4.483	23.013	23.151	0.259	0.073	4.496	8.059	1.523	0.394	0.668	0.202	1.950	
340.4	65	34	6	0.072	4.664	21.178	21.307	0.232	0.072	4.677	8.396	1.511	0.351	0.648	0.197	1.782	
337.9	67.5	28	12	0.070	4.842	17.012	19.103	0.205	0.070	4.855	8.730	1.500	0.308	0.627	0.191	1.613	
335.4	70	25	12	0.069	5.016	14.833	16.855	0.179	0.069	5.029	9.060	1.489	0.267	0.607	0.185	1.443	
332.9	72.5	83	12	0.081	5.204	48.027	51.097	1.000	0.081	5.217	9.404	1.478	1.478	0.587	0.179	N60cs>25	
330.4	75	40	12	0.074	5.398	22.570	24.836	0.289	0.074	5.411	9.754	1.468	0.424	0.567	0.173	2.451	
327.9	77.5	21	12	0.068	5.576	11.585	13.504	0.145	0.068	5.589	10.088	1.458	0.211	0.546	0.167	1.263	
325.4	80	13	6	0.063	5.740	7.027	7.090	0.088	0.063	5.753	10.408	1.450	0.128	0.526	0.161	0.795	

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-12** **1000 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **413.00** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **13.00** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORIZ. GROUND SURFACE ACCELERATION ===== **0.100** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.5** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **0.00** FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground
Shear Stress
Correct. Factor
<b>(K<math>\alpha</math>)= 1.00</b>
Earthquake
Magnitude
Scaling Factor
<b>(MSF)= 1.000</b>

Elev. of Sample (Feet)	Boring Data			Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> )60	Fines Content Corrected (N <sub>1</sub> )60cs	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K $\sigma$ )(K $\omega$ )(MSF)				
410.5	2.5	9	50	0.117	0.300	11.815	19.178	0.205	0.117	0.846	0.846	1.000	0.205	0.994	0.065	ABO. WAT.
408	5	3	50	0.106	0.579	4.052	9.862	0.112	0.106	1.125	1.125	1.000	0.112	0.989	0.064	ABO. WAT.
405.5	7.5	1	50	0.097	0.833	1.265	6.518	0.084	0.097	1.379	1.379	1.000	0.084	0.983	0.064	ABO. WAT.
403	10	8	50	0.059	1.028	9.361	16.233	0.173	0.116	1.645	1.645	1.000	0.173	0.977	0.064	ABO. WAT.
400.5	12.5	7	50	0.058	1.174	7.868	14.442	0.155	0.115	1.934	1.934	1.000	0.155	0.971	0.063	ABO. WAT.
398	15	6	50	0.057	1.318	6.529	12.835	0.139	0.057	2.149	2.274	0.997	0.139	0.966	0.066	NL
395.5	17.5	3	50	0.052	1.454	3.186	8.823	0.103	0.052	2.285	2.566	0.985	0.101	0.960	0.070	NL
393	20	2	12	0.049	1.580	2.088	3.707	0.063	0.049	2.411	2.848	0.975	0.061	0.954	0.073	0.836
390.5	22.5	11	6	0.062	1.719	11.273	11.356	0.125	0.062	2.550	3.143	0.964	0.121	0.948	0.076	1.592
388	25	11	6	0.062	1.874	11.050	11.132	0.123	0.062	2.705	3.454	0.952	0.117	0.943	0.078	1.500
385.5	27.5	11	50	0.062	2.029	10.862	18.034	0.192	0.062	2.860	3.765	0.942	0.181	0.937	0.080	NL
383	30	5	50	0.055	2.175	4.794	10.753	0.120	0.055	3.006	4.067	0.933	0.112	0.931	0.082	NL
380.5	32.5	4	50	0.054	2.311	3.721	9.465	0.108	0.054	3.142	4.359	0.924	0.100	0.911	0.082	NL
378	35	21	50	0.068	2.464	18.917	27.700	0.359	0.068	3.295	4.668	0.916	0.329	0.891	0.082	N60cs>25
375.5	37.5	3	6	0.052	2.614	2.624	2.666	0.050	0.052	3.445	4.974	0.907	0.045	0.870	0.082	0.549
373	40	5	6	0.055	2.748	4.265	4.315	0.067	0.055	3.579	5.264	0.901	0.060	0.850	0.081	0.741
370.5	42.5	24	50	0.069	2.903	19.918	28.902	0.406	0.069	3.734	5.575	0.893	0.363	0.830	0.081	N60cs>25
368	45	7	6	0.058	3.062	5.656	5.712	0.077	0.058	3.893	5.890	0.886	0.068	0.810	0.080	0.850
365.5	47.5	28	6	0.070	3.222	22.057	22.190	0.245	0.070	4.053	6.206	0.878	0.215	0.789	0.079	2.722
363	50	17	6	0.066	3.392	13.052	13.143	0.142	0.066	4.223	6.532	0.871	0.124	0.769	0.077	1.610
360.5	52.5	19	6	0.067	3.558	14.243	14.340	0.153	0.067	4.389	6.854	0.865	0.132	0.749	0.076	1.737
358	55	19	6	0.067	3.726	13.918	14.013	0.150	0.067	4.557	7.178	0.858	0.129	0.729	0.075	1.720
355.5	57.5	16	6	0.065	3.891	11.469	11.553	0.127	0.065	4.722	7.499	0.852	0.108	0.708	0.073	1.479
353	60	17	6	0.066	4.055	11.588	11.672	0.128	0.066	4.886	7.819	0.846	0.108	0.688	0.072	1.500
350.5	62.5	17	6	0.066	4.220	11.299	11.382	0.126	0.066	5.051	8.140	0.841	0.106	0.668	0.070	1.514
348	65	39	6	0.073	4.394	25.258	25.406	0.300	0.073	5.225	8.470	0.835	0.251	0.648	0.068	N60cs>25
345.5	67.5	46	6	0.075	4.579	29.001	29.167	0.418	0.075	5.410	8.811	0.829	0.347	0.627	0.066	N60cs>25
343	70	29	6	0.071	4.762	17.816	17.929	0.191	0.071	5.593	9.150	0.824	0.157	0.607	0.065	2.415
340.5	72.5	35	6	0.072	4.941	20.978	21.106	0.230	0.072	5.772	9.485	0.818	0.188	0.587	0.063	2.984
338	75	19	6	0.067	5.115	11.124	11.206	0.124	0.067	5.946	9.815	0.814	0.101	0.567	0.061	1.656
335.5	77.5	42	7	0.074	5.291	24.028	24.353	0.280	0.074	6.122	10.147	0.809	0.227	0.546	0.059	3.847
333	80	50	6	0.076	5.479	27.922	28.083	0.372	0.076	6.310	10.491	0.804	0.299	0.526	0.057	N60cs>25
330.5	82.5	54	6	0.076	5.669	29.446	29.614	0.443	0.076	6.500	10.837	0.799	0.354	0.506	0.055	N60cs>25
328	85	42	6	0.074	5.857	22.381	22.516	0.250	0.074	6.688	11.181	0.795	0.199	0.486	0.053	3.755
325.5	87.5	19	12	0.067	6.033	9.956	11.824	0.130	0.067	6.864	11.513	0.791	0.103	0.465	0.051	2.020
323	90	8	12	0.059	6.191	4.192	5.878	0.079	0.059	7.022	11.827	0.787	0.062	0.445	0.049	1.265
320.5	92.5	52	12	0.076	6.360	27.248	29.662	0.446	0.076	7.191	12.152	0.783	0.349	0.425	0.047	N60cs>25
318	95	30	6	0.071	6.544	15.720	15.824	0.168	0.071	7.375	12.492	0.779	0.131	0.405	0.045	2.911
315.5	97.5	39	6	0.073	6.724	20.436	20.562	0.223	0.073	7.555	12.828	0.776	0.173	0.384	0.042	4.119
313	100	29	6	0.071	6.904	15.196	15.297	0.163	0.071	7.735	13.164	0.772	0.126	0.364	0.040	3.150
310.5	102.5	71	6	0.079	7.092	37.204	37.408	1.000	0.079	7.923	13.508	0.768	0.768	0.344	0.038	N60cs>25
308	105	56	6	0.077	7.287	29.344	29.511	0.437	0.077	8.118	13.859	0.764	0.334	0.324	0.036	N60cs>25
305.5	107.5	100	6	0.083	7.487	52.400	52.676	1.000	0.083	8.318	14.215	0.761	0.761	0.303	0.034	N60cs>25
303	110	100	6	0.083	7.695	52.400	52.676	1.000	0.083	8.526	14.579	0.757	0.757	0.283	0.031	N60cs>25
300.5	112.5	100	6	0.083	7.903	52.400	52.676	1.000	0.083	8.734	14.943	0.753	0.753	0.263	0.029	N60cs>25
299.5	113.5	100	5	0.083	7.986	52.400	52.400	1.000	0.083	8.817	15.088	0.752	0.752	0.255	0.028	N60cs>25

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO  
 \*Mag<6.0 = duration unlikely to cause Lique

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER =====	<b>WB-12</b>	<b>1000 Short period</b>
ELEVATION OF BORING GROUND SURFACE =====	<b>413.00</b>	FT.
DEPTH TO GROUNDWATER DURING DRILLING =====	<b>8.50</b>	FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER DURING EARTHQUAKE =====	<b>13.00</b>	FT. (Below Finished Grade Cut or Fill Surface)
MAX. HORIZ. GROUND SURFACE ACCELERATION =====	<b>0.190</b>	Coefficient of Gravity
DESIGN EARTHQUAKE MEAN MAGNITUDE =====	<b>5.6</b>	Moment Magnitude Scale
FINISHED GRADE FILL OR CUT FROM BORING SURFACE =====	<b>0.00</b>	FT. (Which is 0 ksf Effect. Surch. Fill Press.)
ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER =====	<b>2</b>	(1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(Ka)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 2.112</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)		Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> )60	Fines Content Corrected (N <sub>1</sub> )60cs	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining. Sloping & Mag. Correct. (Kσ)(Kα)(MSF)				
410.5	2.5	9	50		0.117	0.300	11.815	19.178	0.205	0.117	0.846	0.846	2.112	0.433	0.994	0.123	ABO. WAT.
408	5	3	50		0.106	0.579	4.052	9.862	0.112	0.106	1.125	1.125	2.112	0.237	0.989	0.122	ABO. WAT.
405.5	7.5	1	50		0.097	0.833	1.265	6.518	0.084	0.097	1.379	1.379	2.112	0.177	0.983	0.121	ABO. WAT.
403	10	8	50		0.059	1.028	9.361	16.233	0.173	0.116	1.645	1.645	2.112	0.365	0.977	0.121	ABO. WAT.
400.5	12.5	7	50		0.058	1.174	7.868	14.442	0.155	0.115	1.934	1.934	2.112	0.327	0.971	0.120	ABO. WAT.
398	15	6	50		0.057	1.318	6.529	12.835	0.139	0.057	2.149	2.274	2.106	0.293	0.966	0.126	NL
395.5	17.5	3	50		0.052	1.454	3.186	8.823	0.103	0.052	2.285	2.566	2.081	0.214	0.960	0.133	NL
393	20	2	12		0.049	1.580	2.088	3.707	0.063	0.049	2.411	2.848	2.058	0.130	0.954	0.139	0.935
390.5	22.5	11	6		0.062	1.719	11.273	11.356	0.125	0.062	2.550	3.143	2.035	0.254	0.948	0.144	1.764
388	25	11	6		0.062	1.874	11.050	11.132	0.123	0.062	2.705	3.454	2.012	0.247	0.943	0.149	1.658
385.5	27.5	11	50		0.062	2.029	10.862	18.034	0.192	0.062	2.860	3.765	1.989	0.382	0.937	0.152	NL
383	30	5	50		0.055	2.175	4.794	10.753	0.120	0.055	3.006	4.067	1.970	0.236	0.931	0.156	NL
380.5	32.5	4	50		0.054	2.311	3.721	9.465	0.108	0.054	3.142	4.359	1.952	0.211	0.911	0.156	NL
378	35	21	50		0.068	2.464	18.917	27.700	0.359	0.068	3.295	4.668	1.934	0.694	0.891	0.156	N60cs>25
375.5	37.5	3	6		0.052	2.614	2.624	2.666	0.050	0.052	3.445	4.974	1.917	0.096	0.870	0.155	0.619
373	40	5	6		0.055	2.748	4.265	4.315	0.067	0.055	3.579	5.264	1.902	0.127	0.850	0.154	0.825
370.5	42.5	24	50		0.069	2.903	19.918	28.902	0.406	0.069	3.734	5.575	1.886	0.766	0.830	0.153	N60cs>25
368	45	7	6		0.058	3.062	5.656	5.712	0.077	0.058	3.893	5.890	1.870	0.144	0.810	0.151	0.954
365.5	47.5	28	6		0.070	3.222	22.057	22.190	0.245	0.070	4.053	6.206	1.855	0.454	0.789	0.149	3.047
363	50	17	6		0.066	3.392	13.052	13.143	0.142	0.066	4.223	6.532	1.840	0.261	0.769	0.147	1.776
360.5	52.5	19	6		0.067	3.558	14.243	14.340	0.153	0.067	4.389	6.854	1.826	0.279	0.749	0.144	1.938
358	55	19	6		0.067	3.726	13.918	14.013	0.150	0.067	4.557	7.178	1.812	0.272	0.729	0.142	1.915
355.5	57.5	16	6		0.065	3.891	11.469	11.553	0.127	0.065	4.722	7.499	1.799	0.228	0.708	0.139	1.640
353	60	17	6		0.066	4.055	11.588	11.672	0.128	0.066	4.886	7.819	1.787	0.229	0.688	0.136	1.684
350.5	62.5	17	6		0.066	4.220	11.299	11.382	0.126	0.066	5.051	8.140	1.775	0.224	0.668	0.133	1.684
348	65	39	6		0.073	4.394	25.258	25.406	0.300	0.073	5.225	8.470	1.763	0.529	0.648	0.130	N60cs>25
345.5	67.5	46	6		0.075	4.579	29.001	29.167	0.418	0.075	5.410	8.811	1.751	0.732	0.627	0.126	N60cs>25
343	70	29	6		0.071	4.762	17.816	17.929	0.191	0.071	5.593	9.150	1.740	0.332	0.607	0.123	2.699
340.5	72.5	35	6		0.072	4.941	20.978	21.106	0.230	0.072	5.772	9.485	1.729	0.398	0.587	0.119	3.345
338	75	19	6		0.067	5.115	11.124	11.206	0.124	0.067	5.946	9.815	1.718	0.213	0.567	0.116	1.836
335.5	77.5	42	7		0.074	5.291	24.028	24.353	0.280	0.074	6.122	10.147	1.708	0.478	0.546	0.112	4.268
333	80	50	6		0.076	5.479	27.922	28.083	0.372	0.076	6.310	10.491	1.698	0.632	0.526	0.108	N60cs>25
330.5	82.5	54	6		0.076	5.669	29.446	29.614	0.443	0.076	6.500	10.837	1.688	0.748	0.506	0.104	N60cs>25
328	85	42	6		0.074	5.857	22.381	22.516	0.250	0.074	6.688	11.181	1.678	0.420	0.486	0.100	4.200
325.5	87.5	19	12		0.067	6.033	9.956	11.824	0.130	0.067	6.864	11.513	1.670	0.217	0.465	0.096	2.260
323	90	8	12		0.059	6.191	4.192	5.878	0.079	0.059	7.022	11.827	1.662	0.131	0.445	0.093	1.409
320.5	92.5	52	12		0.076	6.360	27.248	29.662	0.446	0.076	7.191	12.152	1.654	0.738	0.425	0.089	N60cs>25
318	95	30	6		0.071	6.544	15.720	15.824	0.168	0.071	7.375	12.492	1.646	0.277	0.405	0.085	3.259
315.5	97.5	39	6		0.073	6.724	20.436	20.562	0.223	0.073	7.555	12.828	1.638	0.365	0.384	0.081	4.506
313	100	29	6		0.071	6.904	15.196	15.297	0.163	0.071	7.735	13.164	1.630	0.266	0.364	0.077	3.455
310.5	102.5	71	6		0.079	7.092	37.204	37.408	1.000	0.079	7.923	13.508	1.622	1.622	0.344	0.072	N60cs>25
308	105	56	6		0.077	7.287	29.344	29.511	0.437	0.077	8.118	13.859	1.615	0.706	0.324	0.068	N60cs>25
305.5	107.5	100	6		0.083	7.487	52.400	52.676	1.000	0.083	8.318	14.215	1.607	1.607	0.303	0.064	N60cs>25
303	110	100	6		0.083	7.695	52.400	52.676	1.000	0.083	8.526	14.579	1.599	1.599	0.283	0.060	N60cs>25
300.5	112.5	100	6		0.083	7.903	52.400	52.676	1.000	0.083	8.734	14.943	1.591	1.591	0.263	0.056	N60cs>25
299.5	113.5	100	5		0.083	7.986	52.400	52.400	1.000	0.083	8.817	15.088	1.588	1.588	0.255	0.054	N60cs>25

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO  
 \*Mag<6.0 = duration unlikely to cause Lique

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-12 2500 Long period  
 ELEVATION OF BORING GROUND SURFACE ===== 413.00 FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 13.00 FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.120 Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 7.7 Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 0.00 FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground	
Shear Stress	
Correct. Factor	
(Ka)=	1.00
Earthquake	
Magnitude	
Scaling Factor	
(MSF)=	0.935

Elev. of Sample (Feet)	Boring Data			Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>ω</sub> )(MSF)				
410.5	2.5	9	50	0.117	0.300	11.815	19.178	0.205	0.117	0.846	0.846	0.935	0.192	0.994	0.078	ABO. WAT.
408	5	3	50	0.106	0.579	4.052	9.862	0.112	0.106	1.125	1.125	0.935	0.105	0.989	0.077	ABO. WAT.
405.5	7.5	1	50	0.097	0.833	1.265	6.518	0.084	0.097	1.379	1.379	0.935	0.079	0.983	0.077	ABO. WAT.
403	10	8	50	0.059	1.028	9.361	16.233	0.173	0.116	1.645	1.645	0.935	0.162	0.977	0.076	ABO. WAT.
400.5	12.5	7	50	0.058	1.174	7.868	14.442	0.155	0.115	1.934	1.934	0.935	0.145	0.971	0.076	ABO. WAT.
398	15	6	50	0.057	1.318	6.529	12.835	0.139	0.057	2.149	2.274	0.932	0.130	0.966	0.080	NL
395.5	17.5	3	50	0.052	1.454	3.186	8.823	0.103	0.052	2.285	2.566	0.921	0.095	0.960	0.084	NL
393	20	2	12	0.049	1.580	2.088	3.707	0.063	0.049	2.411	2.848	0.911	0.057	0.954	0.088	0.648
390.5	22.5	11	6	0.062	1.719	11.273	11.356	0.125	0.062	2.550	3.143	0.901	0.113	0.948	0.091	1.242
388	25	11	6	0.062	1.874	11.050	11.132	0.123	0.062	2.705	3.454	0.891	0.110	0.943	0.094	1.170
385.5	27.5	11	50	0.062	2.029	10.862	18.034	0.192	0.062	2.860	3.765	0.881	0.169	0.937	0.096	NL
383	30	5	50	0.055	2.175	4.794	10.753	0.120	0.055	3.006	4.067	0.872	0.105	0.931	0.098	NL
380.5	32.5	4	50	0.054	2.311	3.721	9.465	0.108	0.054	3.142	4.359	0.864	0.093	0.911	0.099	NL
378	35	21	50	0.068	2.464	18.917	27.700	0.359	0.068	3.295	4.668	0.856	0.307	0.891	0.098	N60cs>25
375.5	37.5	3	6	0.052	2.614	2.624	2.666	0.050	0.052	3.445	4.974	0.848	0.042	0.870	0.098	0.429
373	40	5	6	0.055	2.748	4.265	4.315	0.067	0.055	3.579	5.264	0.842	0.056	0.850	0.098	0.571
370.5	42.5	24	50	0.069	2.903	19.918	28.902	0.406	0.069	3.734	5.575	0.835	0.339	0.830	0.097	N60cs>25
368	45	7	6	0.058	3.062	5.656	5.712	0.077	0.058	3.893	5.890	0.828	0.064	0.810	0.096	0.667
365.5	47.5	28	6	0.070	3.222	22.057	22.190	0.245	0.070	4.053	6.206	0.821	0.201	0.789	0.094	2.138
363	50	17	6	0.066	3.392	13.052	13.143	0.142	0.066	4.223	6.532	0.815	0.116	0.769	0.093	1.247
360.5	52.5	19	6	0.067	3.558	14.243	14.340	0.153	0.067	4.389	6.854	0.808	0.124	0.749	0.091	1.363
358	55	19	6	0.067	3.726	13.918	14.013	0.150	0.067	4.557	7.178	0.802	0.120	0.729	0.090	1.333
355.5	57.5	16	6	0.065	3.891	11.469	11.553	0.127	0.065	4.722	7.499	0.797	0.101	0.708	0.088	1.148
353	60	17	6	0.066	4.055	11.588	11.672	0.128	0.066	4.886	7.819	0.791	0.101	0.688	0.086	1.174
350.5	62.5	17	6	0.066	4.220	11.299	11.382	0.126	0.066	5.051	8.140	0.786	0.099	0.668	0.084	1.179
348	65	39	6	0.073	4.394	25.258	25.406	0.300	0.073	5.225	8.470	0.781	0.234	0.648	0.082	N60cs>25
345.5	67.5	46	6	0.075	4.579	29.001	29.167	0.418	0.075	5.410	8.811	0.775	0.324	0.627	0.080	N60cs>25
343	70	29	6	0.071	4.762	17.816	17.929	0.191	0.071	5.593	9.150	0.770	0.147	0.607	0.077	1.909
340.5	72.5	35	6	0.072	4.941	20.978	21.106	0.230	0.072	5.772	9.485	0.765	0.176	0.587	0.075	2.347
338	75	19	6	0.067	5.115	11.124	11.206	0.124	0.067	5.946	9.815	0.761	0.094	0.567	0.073	1.288
335.5	77.5	42	7	0.074	5.291	24.028	24.353	0.280	0.074	6.122	10.147	0.756	0.212	0.546	0.071	2.986
333	80	50	6	0.076	5.479	27.922	28.083	0.372	0.076	6.310	10.491	0.752	0.280	0.526	0.068	N60cs>25
330.5	82.5	54	6	0.076	5.669	29.446	29.614	0.443	0.076	6.500	10.837	0.747	0.331	0.506	0.066	N60cs>25
328	85	42	6	0.074	5.857	22.381	22.516	0.250	0.074	6.688	11.181	0.743	0.186	0.486	0.063	2.952
325.5	87.5	19	12	0.067	6.033	9.956	11.824	0.130	0.067	6.864	11.513	0.739	0.096	0.465	0.061	1.574
323	90	8	12	0.059	6.191	4.192	5.878	0.079	0.059	7.022	11.827	0.736	0.058	0.445	0.058	1.000
320.5	92.5	52	12	0.076	6.360	27.248	29.662	0.446	0.076	7.191	12.152	0.732	0.326	0.425	0.056	N60cs>25
318	95	30	6	0.071	6.544	15.720	15.824	0.168	0.071	7.375	12.492	0.729	0.122	0.405	0.054	2.259
315.5	97.5	39	6	0.073	6.724	20.436	20.562	0.223	0.073	7.555	12.828	0.725	0.162	0.384	0.051	3.176
313	100	29	6	0.071	6.904	15.196	15.297	0.163	0.071	7.735	13.164	0.722	0.118	0.364	0.048	2.458
310.5	102.5	71	6	0.079	7.092	37.204	37.408	1.000	0.079	7.923	13.508	0.718	0.718	0.344	0.046	N60cs>25
308	105	56	6	0.077	7.287	29.344	29.511	0.437	0.077	8.118	13.859	0.715	0.312	0.324	0.043	N60cs>25
305.5	107.5	100	6	0.083	7.487	52.400	52.676	1.000	0.083	8.318	14.215	0.711	0.711	0.303	0.040	N60cs>25
303	110	100	6	0.083	7.695	52.400	52.676	1.000	0.083	8.526	14.579	0.708	0.708	0.283	0.038	N60cs>25
300.5	112.5	100	6	0.083	7.903	52.400	52.676	1.000	0.083	8.734	14.943	0.704	0.704	0.263	0.035	N60cs>25
299.5	113.5	100	5	0.083	7.986	52.400	52.400	1.000	0.083	8.817	15.088	0.703	0.703	0.255	0.034	N60cs>25

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO  
 \*Mag<6.0 = duration unlikely to cause Lique

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-12 **2500 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== 413.00 FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 13.00 FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.260 Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 6.0 Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 0.00 FT. (Which is 0 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(Ka)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.770</b>

Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
Elev. of Sample (Feet)	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (Kσ)(Kω)(MSF)				
410.5	2.5	9	50	0.117	0.300	11.815	19.178	0.205	0.117	0.846	0.846	1.770	0.363	0.994	0.168	ABO. WAT.
408	5	3	50	0.106	0.579	4.052	9.862	0.112	0.106	1.125	1.125	1.770	0.198	0.989	0.167	ABO. WAT.
405.5	7.5	1	50	0.097	0.833	1.265	6.518	0.084	0.097	1.379	1.379	1.770	0.149	0.983	0.166	ABO. WAT.
403	10	8	50	0.059	1.028	9.361	16.233	0.173	0.116	1.645	1.645	1.770	0.306	0.977	0.165	ABO. WAT.
400.5	12.5	7	50	0.058	1.174	7.868	14.442	0.155	0.115	1.934	1.934	1.770	0.274	0.971	0.164	ABO. WAT.
398	15	6	50	0.057	1.318	6.529	12.835	0.139	0.057	2.149	2.274	1.765	0.245	0.966	0.173	NL
395.5	17.5	3	50	0.052	1.454	3.186	8.823	0.103	0.052	2.285	2.566	1.744	0.180	0.960	0.182	NL
393	20	2	12	0.049	1.580	2.088	3.707	0.063	0.049	2.411	2.848	1.725	0.109	0.954	0.190	0.574
390.5	22.5	11	6	0.062	1.719	11.273	11.356	0.125	0.062	2.550	3.143	1.706	0.213	0.948	0.197	1.081
388	25	11	6	0.062	1.874	11.050	11.132	0.123	0.062	2.705	3.454	1.686	0.207	0.943	0.203	1.020
385.5	27.5	11	50	0.062	2.029	10.862	18.034	0.192	0.062	2.860	3.765	1.667	0.320	0.937	0.208	NL
383	30	5	50	0.055	2.175	4.794	10.753	0.120	0.055	3.006	4.067	1.651	0.198	0.931	0.213	NL
380.5	32.5	4	50	0.054	2.311	3.721	9.465	0.108	0.054	3.142	4.359	1.636	0.177	0.911	0.214	NL
378	35	21	50	0.068	2.464	18.917	27.700	0.359	0.068	3.295	4.668	1.621	0.582	0.891	0.213	N60cs>25
375.5	37.5	3	6	0.052	2.614	2.624	2.666	0.050	0.052	3.445	4.974	1.606	0.080	0.870	0.212	0.377
373	40	5	6	0.055	2.748	4.265	4.315	0.067	0.055	3.579	5.264	1.594	0.107	0.850	0.211	0.507
370.5	42.5	24	50	0.069	2.903	19.918	28.902	0.406	0.069	3.734	5.575	1.581	0.642	0.830	0.209	N60cs>25
368	45	7	6	0.058	3.062	5.656	5.712	0.077	0.058	3.893	5.890	1.567	0.121	0.810	0.207	0.585
365.5	47.5	28	6	0.070	3.222	22.057	22.190	0.245	0.070	4.053	6.206	1.555	0.381	0.789	0.204	1.868
363	50	17	6	0.066	3.392	13.052	13.143	0.142	0.066	4.223	6.532	1.542	0.219	0.769	0.201	1.090
360.5	52.5	19	6	0.067	3.558	14.243	14.340	0.153	0.067	4.389	6.854	1.530	0.234	0.749	0.198	1.182
358	55	19	6	0.067	3.726	13.918	14.013	0.150	0.067	4.557	7.178	1.519	0.228	0.729	0.194	1.175
355.5	57.5	16	6	0.065	3.891	11.469	11.553	0.127	0.065	4.722	7.499	1.508	0.192	0.708	0.190	1.011
353	60	17	6	0.066	4.055	11.588	11.672	0.128	0.066	4.886	7.819	1.498	0.192	0.688	0.186	1.032
350.5	62.5	17	6	0.066	4.220	11.299	11.382	0.126	0.066	5.051	8.140	1.488	0.187	0.668	0.182	1.027
348	65	39	6	0.073	4.394	25.258	25.406	0.300	0.073	5.225	8.470	1.478	0.443	0.648	0.178	N60cs>25
345.5	67.5	46	6	0.075	4.579	29.001	29.167	0.418	0.075	5.410	8.811	1.468	0.614	0.627	0.173	N60cs>25
343	70	29	6	0.071	4.762	17.816	17.929	0.191	0.071	5.593	9.150	1.458	0.278	0.607	0.168	1.655
340.5	72.5	35	6	0.072	4.941	20.978	21.106	0.230	0.072	5.772	9.485	1.449	0.333	0.587	0.163	2.043
338	75	19	6	0.067	5.115	11.124	11.206	0.124	0.067	5.946	9.815	1.440	0.179	0.567	0.158	1.133
335.5	77.5	42	7	0.074	5.291	24.028	24.353	0.280	0.074	6.122	10.147	1.432	0.401	0.546	0.153	2.621
333	80	50	6	0.076	5.479	27.922	28.083	0.372	0.076	6.310	10.491	1.423	0.529	0.526	0.148	N60cs>25
330.5	82.5	54	6	0.076	5.669	29.446	29.614	0.443	0.076	6.500	10.837	1.415	0.627	0.506	0.143	N60cs>25
328	85	42	6	0.074	5.857	22.381	22.516	0.250	0.074	6.688	11.181	1.407	0.352	0.486	0.137	2.569
325.5	87.5	19	12	0.067	6.033	9.956	11.824	0.130	0.067	6.864	11.513	1.399	0.182	0.465	0.132	1.379
323	90	8	12	0.059	6.191	4.192	5.878	0.079	0.059	7.022	11.827	1.393	0.110	0.445	0.127	0.866
320.5	92.5	52	12	0.076	6.360	27.248	29.662	0.446	0.076	7.191	12.152	1.386	0.618	0.425	0.121	N60cs>25
318	95	30	6	0.071	6.544	15.720	15.824	0.168	0.071	7.375	12.492	1.379	0.232	0.405	0.116	2.000
315.5	97.5	39	6	0.073	6.724	20.436	20.562	0.223	0.073	7.555	12.828	1.373	0.306	0.384	0.110	2.782
313	100	29	6	0.071	6.904	15.196	15.297	0.163	0.071	7.735	13.164	1.366	0.223	0.364	0.105	2.124
310.5	102.5	71	6	0.079	7.092	37.204	37.408	1.000	0.079	7.923	13.508	1.360	1.360	0.344	0.099	N60cs>25
308	105	56	6	0.077	7.287	29.344	29.511	0.437	0.077	8.118	13.859	1.353	0.591	0.324	0.093	N60cs>25
305.5	107.5	100	6	0.083	7.487	52.400	52.676	1.000	0.083	8.318	14.215	1.347	1.347	0.303	0.088	N60cs>25
303	110	100	6	0.083	7.695	52.400	52.676	1.000	0.083	8.526	14.579	1.340	1.340	0.283	0.082	N60cs>25
300.5	112.5	100	6	0.083	7.903	52.400	52.676	1.000	0.083	8.734	14.943	1.334	1.334	0.263	0.076	N60cs>25
299.5	113.5	100	5	0.083	7.986	52.400	52.400	1.000	0.083	8.817	15.088	1.331	1.331	0.255	0.074	N60cs>25

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO  
 \*Mag<6.0 = duration unlikely to cause Lique

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-01** **1000 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **406.00** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **45.00** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.100** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.5** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **39.00** FT. (Which is 4.68 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<math>\alpha</math>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.000</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K $\sigma$ )(K $\alpha$ )(MSF)					
403.5	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	5.162	5.162	0.837	0.116	0.838	0.054	ABO. WAT.	
401	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	5.437	5.437	0.828	0.104	0.818	0.053	ABO. WAT.	
398.5	7.5	5	50	0.111	0.850	6.263	12.516	0.136	0.055	5.642	5.736	0.822	0.112	0.797	0.053	NL	
396	10	2	50	0.049	1.050	2.316	7.779	0.094	0.049	5.772	6.022	0.818	0.077	0.777	0.053	NL	
393.5	12.5	3	50	0.052	1.176	3.369	9.043	0.105	0.052	5.898	6.304	0.815	0.086	0.757	0.053	NL	
391	15	5	14	0.055	1.310	5.457	7.893	0.095	0.055	6.032	6.594	0.811	0.077	0.737	0.052	1.481	
388.5	17.5	14	6	0.064	1.459	14.844	14.943	0.159	0.064	6.181	6.899	0.807	0.128	0.716	0.052	2.462	
386	20	19	6	0.067	1.623	19.570	19.692	0.212	0.067	6.345	7.219	0.803	0.170	0.696	0.051	3.333	
383.5	22.5	17	6	0.066	1.789	17.078	17.188	0.183	0.066	6.511	7.541	0.799	0.146	0.676	0.051	2.863	
381	25	16	6	0.065	1.953	15.744	15.848	0.169	0.065	6.675	7.861	0.795	0.134	0.656	0.050	2.680	
378.5	27.5	24	6	0.069	2.121	23.180	23.319	0.262	0.069	6.843	8.185	0.791	0.207	0.635	0.049	4.224	
376	30	32	6	0.071	2.296	29.862	30.032	1.000	0.071	7.018	8.516	0.787	0.787	0.615	0.049	N60cs>25	
373.5	32.5	25	6	0.069	2.471	22.488	22.623	0.251	0.069	7.193	8.847	0.783	0.197	0.595	0.048	4.104	
371	35	19	6	0.067	2.641	16.532	16.639	0.177	0.067	7.363	9.173	0.780	0.138	0.575	0.047	2.936	
368.5	37.5	14	6	0.064	2.805	11.820	11.905	0.130	0.064	7.527	9.493	0.776	0.101	0.554	0.045	2.244	
366	40	25	6	0.069	2.971	20.509	20.635	0.223	0.069	7.693	9.815	0.773	0.172	0.534	0.044	3.909	
363.5	42.5	35	6	0.072	3.147	27.898	28.059	0.372	0.072	7.869	10.147	0.769	0.286	0.514	0.043	N60cs>25	
361	45	20	6	0.067	3.321	15.518	15.621	0.166	0.067	8.043	10.477	0.766	0.127	0.494	0.042	3.024	
358.5	47.5	19	6	0.067	3.489	14.383	14.480	0.155	0.067	8.211	10.801	0.763	0.118	0.473	0.040	2.950	
356	50	40	6	0.074	3.665	29.544	29.712	0.449	0.074	8.387	11.133	0.760	0.341	0.453	0.039	N60cs>25	
353.5	52.5	17	12	0.066	3.840	12.267	14.208	0.152	0.066	8.562	11.464	0.756	0.115	0.433	0.038	3.026	
351	55	7	6	0.058	3.995	4.952	5.005	0.072	0.058	8.717	11.775	0.754	0.054	0.413	0.036	1.500	
348.5	57.5	9	6	0.060	4.143	6.052	6.110	0.081	0.060	8.865	12.079	0.751	0.061	0.392	0.035	1.743	
346	60	14	6	0.064	4.298	9.197	9.270	0.107	0.064	9.020	12.390	0.749	0.080	0.372	0.033	2.424	
343.5	62.5	21	6	0.068	4.463	13.463	13.556	0.146	0.068	9.185	12.711	0.746	0.109	0.352	0.032	3.406	
341	65	33	6	0.072	4.638	20.631	20.758	0.225	0.072	9.360	13.042	0.743	0.167	0.332	0.030	5.567	
338.5	67.5	28	6	0.070	4.816	17.073	17.183	0.183	0.070	9.538	13.376	0.740	0.135	0.311	0.028	4.821	
336	70	28	6	0.070	4.991	16.669	16.777	0.178	0.070	9.713	13.707	0.738	0.131	0.291	0.027	4.852	
333.5	72.5	31	6	0.071	5.167	18.026	18.140	0.193	0.071	9.889	14.039	0.735	0.142	0.271	0.025	5.680	
331	75	25	6	0.069	5.342	14.208	14.304	0.153	0.069	10.064	14.370	0.732	0.112	0.251	0.023	4.870	
328.5	77.5	27	12	0.070	5.516	15.008	17.035	0.181	0.070	10.238	14.700	0.730	0.132	0.230	0.021	6.286	
326	80	28	12	0.070	5.691	15.227	17.261	0.184	0.070	10.413	15.031	0.727	0.134	0.210	0.020	6.700	

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction



# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-01** **1000 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **406.00** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **45.00** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.190** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **5.6** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **39.00** FT. (Which is 4.68 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(Kα)=</b> 1.00
Earthquake Magnitude Scaling Factor <b>(MSF)=</b> 2.112

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (Kσ)(Kα)(MSF)				
403.5	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	5.162	5.162	1.768	0.246	0.838	0.103	ABO. WAT.
401	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	5.437	5.437	1.749	0.220	0.818	0.101	ABO. WAT.
398.5	7.5	5	50	0.111	0.850	6.263	12.516	0.136	0.055	5.642	5.736	1.736	0.236	0.797	0.100	NL
396	10	2	50	0.049	1.050	2.316	7.779	0.094	0.049	5.772	6.022	1.729	0.163	0.777	0.100	NL
393.5	12.5	3	50	0.052	1.176	3.369	9.043	0.105	0.052	5.898	6.304	1.721	0.181	0.757	0.100	NL
391	15	5	14	0.055	1.310	5.457	7.893	0.095	0.055	6.032	6.594	1.713	0.163	0.737	0.099	1.646
388.5	17.5	14	6	0.064	1.459	14.844	14.943	0.159	0.064	6.181	6.899	1.705	0.271	0.716	0.099	2.737
386	20	19	6	0.067	1.623	19.570	19.692	0.212	0.067	6.345	7.219	1.696	0.360	0.696	0.098	3.673
383.5	22.5	17	6	0.066	1.789	17.078	17.188	0.183	0.066	6.511	7.541	1.687	0.309	0.676	0.097	3.186
381	25	16	6	0.065	1.953	15.744	15.848	0.169	0.065	6.675	7.861	1.679	0.284	0.656	0.095	2.989
378.5	27.5	24	6	0.069	2.121	23.180	23.319	0.262	0.069	6.843	8.185	1.671	0.438	0.635	0.094	4.660
376	30	32	6	0.071	2.296	29.862	30.032	1.000	0.071	7.018	8.516	1.662	1.662	0.615	0.092	N60cs>25
373.5	32.5	25	6	0.069	2.471	22.488	22.623	0.251	0.069	7.193	8.847	1.654	0.415	0.595	0.090	4.611
371	35	19	6	0.067	2.641	16.532	16.639	0.177	0.067	7.363	9.173	1.646	0.291	0.575	0.088	3.307
368.5	37.5	14	6	0.064	2.805	11.820	11.905	0.130	0.064	7.527	9.493	1.639	0.213	0.554	0.086	2.477
366	40	25	6	0.069	2.971	20.509	20.635	0.223	0.069	7.693	9.815	1.632	0.364	0.534	0.084	4.333
363.5	42.5	35	6	0.072	3.147	27.898	28.059	0.372	0.072	7.869	10.147	1.625	0.605	0.514	0.082	N60cs>25
361	45	20	6	0.067	3.321	15.518	15.621	0.166	0.067	8.043	10.477	1.618	0.269	0.494	0.079	3.405
358.5	47.5	19	6	0.067	3.489	14.383	14.480	0.155	0.067	8.211	10.801	1.611	0.250	0.473	0.077	3.247
356	50	40	6	0.074	3.665	29.544	29.712	0.449	0.074	8.387	11.133	1.604	0.720	0.453	0.074	N60cs>25
353.5	52.5	17	12	0.066	3.840	12.267	14.208	0.152	0.066	8.562	11.464	1.598	0.243	0.433	0.072	3.375
351	55	7	6	0.058	3.995	4.952	5.005	0.072	0.058	8.717	11.775	1.592	0.115	0.413	0.069	1.667
348.5	57.5	9	6	0.060	4.143	6.052	6.110	0.081	0.060	8.865	12.079	1.586	0.128	0.392	0.066	1.939
346	60	14	6	0.064	4.298	9.197	9.270	0.107	0.064	9.020	12.390	1.581	0.169	0.372	0.063	2.683
343.5	62.5	21	6	0.068	4.463	13.463	13.556	0.146	0.068	9.185	12.711	1.575	0.230	0.352	0.060	3.833
341	65	33	6	0.072	4.638	20.631	20.758	0.225	0.072	9.360	13.042	1.569	0.353	0.332	0.057	6.193
338.5	67.5	28	6	0.070	4.816	17.073	17.183	0.183	0.070	9.538	13.376	1.563	0.286	0.311	0.054	5.296
336	70	28	6	0.070	4.991	16.669	16.777	0.178	0.070	9.713	13.707	1.558	0.277	0.291	0.051	5.431
333.5	72.5	31	6	0.071	5.167	18.026	18.140	0.193	0.071	9.889	14.039	1.552	0.300	0.271	0.048	6.250
331	75	25	6	0.069	5.342	14.208	14.304	0.153	0.069	10.064	14.370	1.547	0.237	0.251	0.044	5.386
328.5	77.5	27	12	0.070	5.516	15.008	17.035	0.181	0.070	10.238	14.700	1.541	0.279	0.230	0.041	6.805
326	80	28	12	0.070	5.691	15.227	17.261	0.184	0.070	10.413	15.031	1.536	0.283	0.210	0.037	7.649

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-01** **2500 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **406.00** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **45.00** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.110** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.7** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **39.00** FT. (Which is 4.68 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 0.935</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
403.5	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	5.162	5.162	0.783	0.109	0.838	0.060	ABO. WAT.	
401	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	5.437	5.437	0.774	0.098	0.818	0.058	ABO. WAT.	
398.5	7.5	5	50	0.111	0.850	6.263	12.516	0.136	0.055	5.642	5.736	0.769	0.105	0.797	0.058	NL	
396	10	2	50	0.049	1.050	2.316	7.779	0.094	0.049	5.772	6.022	0.765	0.072	0.777	0.058	NL	
393.5	12.5	3	50	0.052	1.176	3.369	9.043	0.105	0.052	5.898	6.304	0.762	0.080	0.757	0.058	NL	
391	15	5	14	0.055	1.310	5.457	7.893	0.095	0.055	6.032	6.594	0.759	0.072	0.737	0.058	1.241	
388.5	17.5	14	6	0.064	1.459	14.844	14.943	0.159	0.064	6.181	6.899	0.755	0.120	0.716	0.057	2.105	
386	20	19	6	0.067	1.623	19.570	19.692	0.212	0.067	6.345	7.219	0.751	0.159	0.696	0.057	2.789	
383.5	22.5	17	6	0.066	1.789	17.078	17.188	0.183	0.066	6.511	7.541	0.747	0.137	0.676	0.056	2.446	
381	25	16	6	0.065	1.953	15.744	15.848	0.169	0.065	6.675	7.861	0.743	0.126	0.656	0.055	2.291	
378.5	27.5	24	6	0.069	2.121	23.180	23.319	0.262	0.069	6.843	8.185	0.740	0.194	0.635	0.054	3.593	
376	30	32	6	0.071	2.296	29.862	30.032	1.000	0.071	7.018	8.516	0.736	0.736	0.615	0.053	N60cs>25	
373.5	32.5	25	6	0.069	2.471	22.488	22.623	0.251	0.069	7.193	8.847	0.732	0.184	0.595	0.052	3.538	
371	35	19	6	0.067	2.641	16.532	16.639	0.177	0.067	7.363	9.173	0.729	0.129	0.575	0.051	2.529	
368.5	37.5	14	6	0.064	2.805	11.820	11.905	0.130	0.064	7.527	9.493	0.726	0.094	0.554	0.050	1.880	
366	40	25	6	0.069	2.971	20.509	20.635	0.223	0.069	7.693	9.815	0.723	0.161	0.534	0.049	3.286	
363.5	42.5	35	6	0.072	3.147	27.898	28.059	0.372	0.072	7.869	10.147	0.719	0.267	0.514	0.047	N60cs>25	
361	45	20	6	0.067	3.321	15.518	15.621	0.166	0.067	8.043	10.477	0.716	0.119	0.494	0.046	2.587	
358.5	47.5	19	6	0.067	3.489	14.383	14.480	0.155	0.067	8.211	10.801	0.713	0.111	0.473	0.044	2.523	
356	50	40	6	0.074	3.665	29.544	29.712	0.449	0.074	8.387	11.133	0.710	0.319	0.453	0.043	N60cs>25	
353.5	52.5	17	12	0.066	3.840	12.267	14.208	0.152	0.066	8.562	11.464	0.707	0.107	0.433	0.041	2.610	
351	55	7	6	0.058	3.995	4.952	5.005	0.072	0.058	8.717	11.775	0.705	0.051	0.413	0.040	1.275	
348.5	57.5	9	6	0.060	4.143	6.052	6.110	0.081	0.060	8.865	12.079	0.702	0.057	0.392	0.038	1.500	
346	60	14	6	0.064	4.298	9.197	9.270	0.107	0.064	9.020	12.390	0.700	0.075	0.372	0.037	2.027	
343.5	62.5	21	6	0.068	4.463	13.463	13.556	0.146	0.068	9.185	12.711	0.697	0.102	0.352	0.035	2.914	
341	65	33	6	0.072	4.638	20.631	20.758	0.225	0.072	9.360	13.042	0.695	0.156	0.332	0.033	4.727	
338.5	67.5	28	6	0.070	4.816	17.073	17.183	0.183	0.070	9.538	13.376	0.692	0.127	0.311	0.031	4.097	
336	70	28	6	0.070	4.991	16.669	16.777	0.178	0.070	9.713	13.707	0.690	0.123	0.291	0.029	4.241	
333.5	72.5	31	6	0.071	5.167	18.026	18.140	0.193	0.071	9.889	14.039	0.687	0.133	0.271	0.028	4.750	
331	75	25	6	0.069	5.342	14.208	14.304	0.153	0.069	10.064	14.370	0.685	0.105	0.251	0.026	4.038	
328.5	77.5	27	12	0.070	5.516	15.008	17.035	0.181	0.070	10.238	14.700	0.682	0.123	0.230	0.024	5.125	
326	80	28	12	0.070	5.691	15.227	17.261	0.184	0.070	10.413	15.031	0.680	0.125	0.210	0.022	5.682	

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-01** **2500 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **406.00** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **45.00** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.270** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **6.0** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **39.00** FT. (Which is 4.68 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.770</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
403.5	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	5.162	5.162	1.481	0.206	0.838	0.147	ABO. WAT.	
401	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	5.437	5.437	1.466	0.185	0.818	0.144	ABO. WAT.	
398.5	7.5	5	50	0.111	0.850	6.263	12.516	0.136	0.055	5.642	5.736	1.455	0.198	0.797	0.142	NL	
396	10	2	50	0.049	1.050	2.316	7.779	0.094	0.049	5.772	6.022	1.449	0.136	0.777	0.142	NL	
393.5	12.5	3	50	0.052	1.176	3.369	9.043	0.105	0.052	5.898	6.304	1.442	0.151	0.757	0.142	NL	
391	15	5	14	0.055	1.310	5.457	7.893	0.095	0.055	6.032	6.594	1.436	0.136	0.737	0.141	0.965	
388.5	17.5	14	6	0.064	1.459	14.844	14.943	0.159	0.064	6.181	6.899	1.429	0.227	0.716	0.140	1.621	
386	20	19	6	0.067	1.623	19.570	19.692	0.212	0.067	6.345	7.219	1.422	0.301	0.696	0.139	2.165	
383.5	22.5	17	6	0.066	1.789	17.078	17.188	0.183	0.066	6.511	7.541	1.414	0.259	0.676	0.137	1.891	
381	25	16	6	0.065	1.953	15.744	15.848	0.169	0.065	6.675	7.861	1.407	0.238	0.656	0.136	1.750	
378.5	27.5	24	6	0.069	2.121	23.180	23.319	0.262	0.069	6.843	8.185	1.400	0.367	0.635	0.133	2.759	
376	30	32	6	0.071	2.296	29.862	30.032	1.000	0.071	7.018	8.516	1.393	1.393	0.615	0.131	N60cs>25	
373.5	32.5	25	6	0.069	2.471	22.488	22.623	0.251	0.069	7.193	8.847	1.386	0.348	0.595	0.128	2.719	
371	35	19	6	0.067	2.641	16.532	16.639	0.177	0.067	7.363	9.173	1.380	0.244	0.575	0.126	1.937	
368.5	37.5	14	6	0.064	2.805	11.820	11.905	0.130	0.064	7.527	9.493	1.374	0.179	0.554	0.123	1.455	
366	40	25	6	0.069	2.971	20.509	20.635	0.223	0.069	7.693	9.815	1.368	0.305	0.534	0.120	2.542	
363.5	42.5	35	6	0.072	3.147	27.898	28.059	0.372	0.072	7.869	10.147	1.362	0.507	0.514	0.116	N60cs>25	
361	45	20	6	0.067	3.321	15.518	15.621	0.166	0.067	8.043	10.477	1.356	0.225	0.494	0.113	1.991	
358.5	47.5	19	6	0.067	3.489	14.383	14.480	0.155	0.067	8.211	10.801	1.350	0.209	0.473	0.109	1.917	
356	50	40	6	0.074	3.665	29.544	29.712	0.449	0.074	8.387	11.133	1.344	0.603	0.453	0.106	N60cs>25	
353.5	52.5	17	12	0.066	3.840	12.267	14.208	0.152	0.066	8.562	11.464	1.339	0.204	0.433	0.102	2.000	
351	55	7	6	0.058	3.995	4.952	5.005	0.072	0.058	8.717	11.775	1.334	0.096	0.413	0.098	0.980	
348.5	57.5	9	6	0.060	4.143	6.052	6.110	0.081	0.060	8.865	12.079	1.330	0.108	0.392	0.094	1.149	
346	60	14	6	0.064	4.298	9.197	9.270	0.107	0.064	9.020	12.390	1.325	0.142	0.372	0.090	1.578	
343.5	62.5	21	6	0.068	4.463	13.463	13.556	0.146	0.068	9.185	12.711	1.320	0.193	0.352	0.085	2.271	
341	65	33	6	0.072	4.638	20.631	20.758	0.225	0.072	9.360	13.042	1.315	0.296	0.332	0.081	3.654	
338.5	67.5	28	6	0.070	4.816	17.073	17.183	0.183	0.070	9.538	13.376	1.310	0.240	0.311	0.077	3.117	
336	70	28	6	0.070	4.991	16.669	16.777	0.178	0.070	9.713	13.707	1.305	0.232	0.291	0.072	3.222	
333.5	72.5	31	6	0.071	5.167	18.026	18.140	0.193	0.071	9.889	14.039	1.301	0.251	0.271	0.068	3.691	
331	75	25	6	0.069	5.342	14.208	14.304	0.153	0.069	10.064	14.370	1.296	0.198	0.251	0.063	3.143	
328.5	77.5	27	12	0.070	5.516	15.008	17.035	0.181	0.070	10.238	14.700	1.292	0.234	0.230	0.058	4.034	
326	80	28	12	0.070	5.691	15.227	17.261	0.184	0.070	10.413	15.031	1.287	0.237	0.210	0.053	4.472	

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-02** **1000 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **406.00** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **43.50** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.100** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.5** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **37.50** FT. (Which is 4.5 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.000</b>

Elev. of Sample (Feet)	Boring Data			Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
403.5	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	4.982	4.982	0.843	0.117	0.850	0.055	ABO. WAT.
401	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	5.257	5.257	0.834	0.105	0.830	0.054	ABO. WAT.
398.5	7.5	2	50	0.102	0.839	2.522	8.026	0.096	0.049	5.455	5.549	0.828	0.079	0.810	0.054	NL
396	10	2	50	0.049	1.028	2.340	7.808	0.094	0.049	5.578	5.828	0.824	0.077	0.789	0.054	NL
393.5	12.5	5	35	0.055	1.158	5.658	11.790	0.129	0.055	5.708	6.114	0.820	0.106	0.769	0.054	1.963
391	15	11	6	0.062	1.304	12.034	12.120	0.132	0.062	5.854	6.416	0.816	0.108	0.749	0.053	2.038
388.5	17.5	13	6	0.063	1.460	13.779	13.873	0.149	0.063	6.010	6.728	0.812	0.121	0.729	0.053	2.283
386	20	16	6	0.065	1.620	16.495	16.602	0.177	0.065	6.170	7.044	0.808	0.143	0.708	0.053	2.698
383.5	22.5	13	6	0.063	1.780	13.092	13.183	0.142	0.063	6.330	7.360	0.804	0.114	0.688	0.052	2.192
381	25	15	6	0.065	1.940	14.809	14.908	0.159	0.065	6.490	7.676	0.799	0.127	0.668	0.051	2.490
378.5	27.5	32	6	0.071	2.110	30.986	31.161	1.000	0.071	6.660	8.002	0.795	0.795	0.648	0.051	N60cs>25
376	30	26	6	0.070	2.286	24.316	24.460	0.282	0.070	6.836	8.334	0.791	0.223	0.627	0.050	4.460
373.5	32.5	25	6	0.069	2.460	22.538	22.674	0.252	0.069	7.010	8.664	0.787	0.198	0.607	0.049	4.041
371	35	17	6	0.066	2.629	14.825	14.924	0.159	0.066	7.179	8.989	0.784	0.125	0.587	0.048	2.604
368.5	37.5	17	6	0.066	2.794	14.381	14.478	0.155	0.066	7.344	9.310	0.780	0.121	0.567	0.047	2.574
366	40	26	6	0.070	2.964	21.354	21.484	0.235	0.070	7.514	9.636	0.776	0.182	0.546	0.046	3.957
363.5	42.5	22	6	0.068	3.137	17.564	17.676	0.188	0.068	7.687	9.965	0.773	0.145	0.526	0.044	3.295
361	45	36	6	0.073	3.313	27.967	28.128	0.374	0.073	7.863	10.297	0.769	0.288	0.506	0.043	N60cs>25
358.5	47.5	31	6	0.071	3.493	23.454	23.594	0.267	0.071	8.043	10.633	0.766	0.205	0.486	0.042	4.881
356	50	27	6	0.070	3.669	19.931	20.054	0.216	0.070	8.219	10.965	0.763	0.165	0.465	0.040	4.125
353.5	52.5	27	6	0.070	3.844	19.472	19.593	0.210	0.070	8.394	11.296	0.759	0.159	0.445	0.039	4.077
351	55	12	12	0.063	4.010	8.237	10.051	0.114	0.063	8.560	11.618	0.756	0.086	0.425	0.037	2.324
348.5	57.5	30	6	0.071	4.178	20.067	20.191	0.218	0.071	8.728	11.942	0.754	0.164	0.405	0.036	4.556
346	60	29	6	0.071	4.356	18.887	19.005	0.203	0.071	8.906	12.276	0.750	0.152	0.384	0.034	4.471
343.5	62.5	29	6	0.071	4.534	18.402	18.518	0.198	0.071	9.084	12.610	0.748	0.148	0.364	0.033	4.485
341	65	39	6	0.073	4.714	24.121	24.264	0.278	0.073	9.264	12.946	0.745	0.207	0.344	0.031	6.677
338.5	67.5	16	6	0.065	4.887	9.661	9.736	0.111	0.065	9.437	13.275	0.742	0.082	0.324	0.030	2.733
336	70	26	6	0.070	5.056	15.343	15.445	0.165	0.070	9.606	13.600	0.739	0.122	0.303	0.028	4.357
333.5	72.5	30	6	0.071	5.232	17.296	17.407	0.185	0.071	9.782	13.932	0.737	0.136	0.283	0.026	5.231
331	75	48	6	0.075	5.415	27.025	27.182	0.344	0.075	9.965	14.271	0.734	0.252	0.263	0.024	N60cs>25
328.5	77.5	62	6	0.078	5.606	34.074	34.264	1.000	0.078	10.156	14.618	0.731	0.731	0.243	0.023	N60cs>25
326	80	32	12	0.071	5.792	17.188	19.284	0.207	0.071	10.342	14.960	0.728	0.151	0.222	0.021	7.190

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-02** **1000 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **406.00** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **43.50** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.190** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **5.6** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **37.50** FT. (Which is 4.5 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 2.112</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
403.5	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	4.982	4.982	1.780	0.247	0.850	0.105	ABO. WAT.
401	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	5.257	5.257	1.761	0.222	0.830	0.103	ABO. WAT.
398.5	7.5	2	50	0.102	0.839	2.522	8.026	0.096	0.049	5.455	5.549	1.748	0.168	0.810	0.102	NL
396	10	2	50	0.049	1.028	2.340	7.808	0.094	0.049	5.578	5.828	1.740	0.164	0.789	0.102	NL
393.5	12.5	5	35	0.055	1.158	5.658	11.790	0.129	0.055	5.708	6.114	1.732	0.223	0.769	0.102	2.186
391	15	11	6	0.062	1.304	12.034	12.120	0.132	0.062	5.854	6.416	1.724	0.228	0.749	0.101	2.257
388.5	17.5	13	6	0.063	1.460	13.779	13.873	0.149	0.063	6.010	6.728	1.715	0.256	0.729	0.101	2.535
386	20	16	6	0.065	1.620	16.495	16.602	0.177	0.065	6.170	7.044	1.706	0.302	0.708	0.100	3.020
383.5	22.5	13	6	0.063	1.780	13.092	13.183	0.142	0.063	6.330	7.360	1.697	0.241	0.688	0.099	2.434
381	25	15	6	0.065	1.940	14.809	14.908	0.159	0.065	6.490	7.676	1.689	0.269	0.668	0.098	2.745
378.5	27.5	32	6	0.071	2.110	30.986	31.161	1.000	0.071	6.660	8.002	1.680	1.680	0.648	0.096	N60cs>25
376	30	26	6	0.070	2.286	24.316	24.460	0.282	0.070	6.836	8.334	1.671	0.471	0.627	0.094	5.011
373.5	32.5	25	6	0.069	2.460	22.538	22.674	0.252	0.069	7.010	8.664	1.663	0.419	0.607	0.093	4.505
371	35	17	6	0.066	2.629	14.825	14.924	0.159	0.066	7.179	8.989	1.655	0.263	0.587	0.091	2.890
368.5	37.5	17	6	0.066	2.794	14.381	14.478	0.155	0.066	7.344	9.310	1.647	0.255	0.567	0.089	2.865
366	40	26	6	0.070	2.964	21.354	21.484	0.235	0.070	7.514	9.636	1.640	0.385	0.546	0.086	4.477
363.5	42.5	22	6	0.068	3.137	17.564	17.676	0.188	0.068	7.687	9.965	1.632	0.307	0.526	0.084	3.655
361	45	36	6	0.073	3.313	27.967	28.128	0.374	0.073	7.863	10.297	1.625	0.608	0.506	0.082	N60cs>25
358.5	47.5	31	6	0.071	3.493	23.454	23.594	0.267	0.071	8.043	10.633	1.618	0.432	0.486	0.079	5.468
356	50	27	6	0.070	3.669	19.931	20.054	0.216	0.070	8.219	10.965	1.611	0.348	0.465	0.077	4.519
353.5	52.5	27	6	0.070	3.844	19.472	19.593	0.210	0.070	8.394	11.296	1.604	0.337	0.445	0.074	4.554
351	55	12	12	0.063	4.010	8.237	10.051	0.114	0.063	8.560	11.618	1.598	0.182	0.425	0.071	2.563
348.5	57.5	30	6	0.071	4.178	20.067	20.191	0.218	0.071	8.728	11.942	1.591	0.347	0.405	0.068	5.103
346	60	29	6	0.071	4.356	18.887	19.005	0.203	0.071	8.906	12.276	1.585	0.322	0.384	0.065	4.954
343.5	62.5	29	6	0.071	4.534	18.402	18.518	0.198	0.071	9.084	12.610	1.579	0.313	0.364	0.062	5.048
341	65	39	6	0.073	4.714	24.121	24.264	0.278	0.073	9.264	12.946	1.573	0.437	0.344	0.059	7.407
338.5	67.5	16	6	0.065	4.887	9.661	9.736	0.111	0.065	9.437	13.275	1.567	0.174	0.324	0.056	3.107
336	70	26	6	0.070	5.056	15.343	15.445	0.165	0.070	9.606	13.600	1.561	0.258	0.303	0.053	4.868
333.5	72.5	30	6	0.071	5.232	17.296	17.407	0.185	0.071	9.782	13.932	1.556	0.288	0.283	0.050	5.760
331	75	48	6	0.075	5.415	27.025	27.182	0.344	0.075	9.965	14.271	1.550	0.533	0.263	0.047	N60cs>25
328.5	77.5	62	6	0.078	5.606	34.074	34.264	1.000	0.078	10.156	14.618	1.544	1.544	0.243	0.043	N60cs>25
326	80	32	12	0.071	5.792	17.188	19.284	0.207	0.071	10.342	14.960	1.538	0.318	0.222	0.040	7.950

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-02** **2500 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **406.00** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **43.50** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.110** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.7** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **37.50** FT. (Which is 4.5 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 0.935</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
403.5	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	4.982	4.982	0.788	0.110	0.850	0.061	ABO. WAT.	
401	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	5.257	5.257	0.780	0.098	0.830	0.059	ABO. WAT.	
398.5	7.5	2	50	0.102	0.839	2.522	8.026	0.096	0.049	5.455	5.549	0.774	0.074	0.810	0.059	NL	
396	10	2	50	0.049	1.028	2.340	7.808	0.094	0.049	5.578	5.828	0.771	0.072	0.789	0.059	NL	
393.5	12.5	5	35	0.055	1.158	5.658	11.790	0.129	0.055	5.708	6.114	0.767	0.099	0.769	0.059	1.678	
391	15	11	6	0.062	1.304	12.034	12.120	0.132	0.062	5.854	6.416	0.763	0.101	0.749	0.059	1.712	
388.5	17.5	13	6	0.063	1.460	13.779	13.873	0.149	0.063	6.010	6.728	0.759	0.113	0.729	0.058	1.948	
386	20	16	6	0.065	1.620	16.495	16.602	0.177	0.065	6.170	7.044	0.755	0.134	0.708	0.058	2.310	
383.5	22.5	13	6	0.063	1.780	13.092	13.183	0.142	0.063	6.330	7.360	0.751	0.107	0.688	0.057	1.877	
381	25	15	6	0.065	1.940	14.809	14.908	0.159	0.065	6.490	7.676	0.748	0.119	0.668	0.056	2.125	
378.5	27.5	32	6	0.071	2.110	30.986	31.161	1.000	0.071	6.660	8.002	0.744	0.744	0.648	0.056	N60cs>25	
376	30	26	6	0.070	2.286	24.316	24.460	0.282	0.070	6.836	8.334	0.740	0.209	0.627	0.055	3.800	
373.5	32.5	25	6	0.069	2.460	22.538	22.674	0.252	0.069	7.010	8.664	0.736	0.185	0.607	0.054	3.426	
371	35	17	6	0.066	2.629	14.825	14.924	0.159	0.066	7.179	8.989	0.733	0.117	0.587	0.053	2.208	
368.5	37.5	17	6	0.066	2.794	14.381	14.478	0.155	0.066	7.344	9.310	0.729	0.113	0.567	0.051	2.216	
366	40	26	6	0.070	2.964	21.354	21.484	0.235	0.070	7.514	9.636	0.726	0.171	0.546	0.050	3.420	
363.5	42.5	22	6	0.068	3.137	17.564	17.676	0.188	0.068	7.687	9.965	0.723	0.136	0.526	0.049	2.776	
361	45	36	6	0.073	3.313	27.967	28.128	0.374	0.073	7.863	10.297	0.719	0.269	0.506	0.047	N60cs>25	
358.5	47.5	31	6	0.071	3.493	23.454	23.594	0.267	0.071	8.043	10.633	0.716	0.191	0.486	0.046	4.152	
356	50	27	6	0.070	3.669	19.931	20.054	0.216	0.070	8.219	10.965	0.713	0.154	0.465	0.044	3.500	
353.5	52.5	27	6	0.070	3.844	19.472	19.593	0.210	0.070	8.394	11.296	0.710	0.149	0.445	0.043	3.465	
351	55	12	12	0.063	4.010	8.237	10.051	0.114	0.063	8.560	11.618	0.707	0.081	0.425	0.041	1.976	
348.5	57.5	30	6	0.071	4.178	20.067	20.191	0.218	0.071	8.728	11.942	0.705	0.154	0.405	0.040	3.850	
346	60	29	6	0.071	4.356	18.887	19.005	0.203	0.071	8.906	12.276	0.702	0.143	0.384	0.038	3.763	
343.5	62.5	29	6	0.071	4.534	18.402	18.518	0.198	0.071	9.084	12.610	0.699	0.138	0.364	0.036	3.833	
341	65	39	6	0.073	4.714	24.121	24.264	0.278	0.073	9.264	12.946	0.696	0.193	0.344	0.034	5.676	
338.5	67.5	16	6	0.065	4.887	9.661	9.736	0.111	0.065	9.437	13.275	0.694	0.077	0.324	0.033	2.333	
336	70	26	6	0.070	5.056	15.343	15.445	0.165	0.070	9.606	13.600	0.691	0.114	0.303	0.031	3.677	
333.5	72.5	30	6	0.071	5.232	17.296	17.407	0.185	0.071	9.782	13.932	0.689	0.127	0.283	0.029	4.379	
331	75	48	6	0.075	5.415	27.025	27.182	0.344	0.075	9.965	14.271	0.686	0.236	0.263	0.027	N60cs>25	
328.5	77.5	62	6	0.078	5.606	34.074	34.264	1.000	0.078	10.156	14.618	0.683	0.683	0.243	0.025	N60cs>25	
326	80	32	12	0.071	5.792	17.188	19.284	0.207	0.071	10.342	14.960	0.681	0.141	0.222	0.023	6.130	

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-02** **2500 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **406.00** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **43.50** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.270** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **6.0** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **37.50** FT. (Which is 4.5 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.770</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
403.5	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	4.982	4.982	1.492	0.207	0.850	0.149	ABO. WAT.	
401	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	5.257	5.257	1.476	0.186	0.830	0.146	ABO. WAT.	
398.5	7.5	2	50	0.102	0.839	2.522	8.026	0.096	0.049	5.455	5.549	1.465	0.141	0.810	0.145	NL	
396	10	2	50	0.049	1.028	2.340	7.808	0.094	0.049	5.578	5.828	1.459	0.137	0.789	0.145	NL	
393.5	12.5	5	35	0.055	1.158	5.658	11.790	0.129	0.055	5.708	6.114	1.452	0.187	0.769	0.145	1.290	
391	15	11	6	0.062	1.304	12.034	12.120	0.132	0.062	5.854	6.416	1.445	0.191	0.749	0.144	1.326	
388.5	17.5	13	6	0.063	1.460	13.779	13.873	0.149	0.063	6.010	6.728	1.437	0.214	0.729	0.143	1.497	
386	20	16	6	0.065	1.620	16.495	16.602	0.177	0.065	6.170	7.044	1.429	0.253	0.708	0.142	1.782	
383.5	22.5	13	6	0.063	1.780	13.092	13.183	0.142	0.063	6.330	7.360	1.422	0.202	0.688	0.140	1.443	
381	25	15	6	0.065	1.940	14.809	14.908	0.159	0.065	6.490	7.676	1.415	0.225	0.668	0.139	1.619	
378.5	27.5	32	6	0.071	2.110	30.986	31.161	1.000	0.071	6.660	8.002	1.408	1.408	0.648	0.137	N60cs>25	
376	30	26	6	0.070	2.286	24.316	24.460	0.282	0.070	6.836	8.334	1.400	0.395	0.627	0.134	2.948	
373.5	32.5	25	6	0.069	2.460	22.538	22.674	0.252	0.069	7.010	8.664	1.393	0.351	0.607	0.132	2.659	
371	35	17	6	0.066	2.629	14.825	14.924	0.159	0.066	7.179	8.989	1.387	0.221	0.587	0.129	1.713	
368.5	37.5	17	6	0.066	2.794	14.381	14.478	0.155	0.066	7.344	9.310	1.381	0.214	0.567	0.126	1.698	
366	40	26	6	0.070	2.964	21.354	21.484	0.235	0.070	7.514	9.636	1.374	0.323	0.546	0.123	2.626	
363.5	42.5	22	6	0.068	3.137	17.564	17.676	0.188	0.068	7.687	9.965	1.368	0.257	0.526	0.120	2.142	
361	45	36	6	0.073	3.313	27.967	28.128	0.374	0.073	7.863	10.297	1.362	0.509	0.506	0.116	N60cs>25	
358.5	47.5	31	6	0.071	3.493	23.454	23.594	0.267	0.071	8.043	10.633	1.356	0.362	0.486	0.113	3.204	
356	50	27	6	0.070	3.669	19.931	20.054	0.216	0.070	8.219	10.965	1.350	0.292	0.465	0.109	2.679	
353.5	52.5	27	6	0.070	3.844	19.472	19.593	0.210	0.070	8.394	11.296	1.344	0.282	0.445	0.105	2.686	
351	55	12	12	0.063	4.010	8.237	10.051	0.114	0.063	8.560	11.618	1.339	0.153	0.425	0.101	1.515	
348.5	57.5	30	6	0.071	4.178	20.067	20.191	0.218	0.071	8.728	11.942	1.334	0.291	0.405	0.097	3.000	
346	60	29	6	0.071	4.356	18.887	19.005	0.203	0.071	8.906	12.276	1.328	0.270	0.384	0.093	2.903	
343.5	62.5	29	6	0.071	4.534	18.402	18.518	0.198	0.071	9.084	12.610	1.323	0.262	0.364	0.089	2.944	
341	65	39	6	0.073	4.714	24.121	24.264	0.278	0.073	9.264	12.946	1.318	0.366	0.344	0.084	4.357	
338.5	67.5	16	6	0.065	4.887	9.661	9.736	0.111	0.065	9.437	13.275	1.313	0.146	0.324	0.080	1.825	
336	70	26	6	0.070	5.056	15.343	15.445	0.165	0.070	9.606	13.600	1.308	0.216	0.303	0.075	2.880	
333.5	72.5	30	6	0.071	5.232	17.296	17.407	0.185	0.071	9.782	13.932	1.304	0.241	0.283	0.071	3.394	
331	75	48	6	0.075	5.415	27.025	27.182	0.344	0.075	9.965	14.271	1.299	0.447	0.263	0.066	N60cs>25	
328.5	77.5	62	6	0.078	5.606	34.074	34.264	1.000	0.078	10.156	14.618	1.294	1.294	0.243	0.061	N60cs>25	
326	80	32	12	0.071	5.792	17.188	19.284	0.207	0.071	10.342	14.960	1.289	0.267	0.222	0.056	4.768	

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-03 1000 Long period  
 ELEVATION OF BORING GROUND SURFACE ===== 405.70 FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 38.95 FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.100 Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 7.5 Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 33.25 FT. (Which is 3.99 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<math>\alpha</math>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.000</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR 7.5 Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> )60	Fines Content Corrected (N <sub>1</sub> )60cs	CRR Resisting Mag 7.5 CRR 7.5	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K $\sigma$ )(K $\alpha$ )(MSF)				
403.2	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	4.456	4.456	0.862	0.120	0.884	0.057	ABO. WAT.
400.7	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	4.731	4.731	0.852	0.107	0.864	0.056	ABO. WAT.
398.2	7.5	2	50	0.102	0.839	2.522	8.026	0.096	0.049	4.929	5.041	0.845	0.081	0.844	0.056	NL
395.7	10	2	50	0.049	1.028	2.340	7.808	0.094	0.049	5.052	5.320	0.841	0.079	0.824	0.056	NL
393.2	12.5	3	50	0.052	1.154	3.401	9.081	0.105	0.052	5.178	5.602	0.836	0.088	0.803	0.056	NL
390.7	15	11	5	0.062	1.297	12.066	12.066	0.132	0.062	5.321	5.901	0.832	0.110	0.783	0.056	1.964
388.2	17.5	17	5	0.066	1.457	18.038	18.038	0.192	0.066	5.481	6.217	0.827	0.159	0.763	0.056	2.839
385.7	20	16	5	0.065	1.621	16.490	16.490	0.175	0.065	5.645	6.537	0.822	0.144	0.743	0.056	2.571
383.2	22.5	17	5	0.066	1.785	17.097	17.097	0.182	0.066	5.809	6.857	0.817	0.149	0.722	0.055	2.709
380.7	25	19	5	0.067	1.951	18.705	18.705	0.200	0.067	5.975	7.179	0.813	0.163	0.702	0.055	2.964
378.2	27.5	17	5	0.066	2.117	16.434	16.434	0.175	0.066	6.141	7.501	0.808	0.141	0.682	0.054	2.611
375.7	30	24	5	0.069	2.286	22.445	22.445	0.248	0.069	6.310	7.826	0.804	0.199	0.662	0.053	3.755
373.2	32.5	13	5	0.063	2.451	11.741	11.741	0.129	0.063	6.475	8.147	0.800	0.103	0.641	0.052	1.981
370.7	35	17	5	0.066	2.612	14.873	14.873	0.159	0.066	6.636	8.464	0.796	0.127	0.621	0.051	2.490
368.2	37.5	19	5	0.067	2.778	16.119	16.119	0.172	0.067	6.802	8.786	0.792	0.136	0.601	0.050	2.720
365.7	40	22	5	0.068	2.947	18.121	18.121	0.193	0.068	6.971	9.111	0.788	0.152	0.581	0.049	3.102
363.2	42.5	33	5	0.072	3.122	26.409	26.409	0.323	0.072	7.146	9.442	0.784	0.253	0.560	0.048	N60cs>25
360.7	45	20	5	0.067	3.296	15.577	15.577	0.166	0.067	7.320	9.772	0.780	0.129	0.540	0.047	2.745
358.2	47.5	23	5	0.068	3.465	17.471	17.471	0.186	0.068	7.489	10.097	0.777	0.145	0.520	0.046	3.152
355.7	50	25	5	0.069	3.636	18.539	18.539	0.198	0.069	7.660	10.424	0.773	0.153	0.500	0.044	3.477
353.2	52.5	35	5	0.072	3.812	25.348	25.348	0.299	0.072	7.836	10.756	0.770	0.230	0.479	0.043	N60cs>25
350.7	55	31	5	0.071	3.991	21.942	21.942	0.241	0.071	8.015	11.091	0.766	0.185	0.459	0.041	4.512
348.2	57.5	29	5	0.071	4.169	19.425	19.425	0.208	0.071	8.193	11.425	0.763	0.159	0.439	0.040	3.975
345.7	60	17	5	0.066	4.340	11.098	11.098	0.123	0.066	8.364	11.752	0.760	0.093	0.419	0.038	2.447
343.2	62.5	28	5	0.070	4.510	17.829	17.829	0.190	0.070	8.534	12.078	0.757	0.144	0.398	0.037	3.892
340.7	65	21	5	0.068	4.683	13.045	13.045	0.141	0.068	8.707	12.407	0.754	0.106	0.378	0.035	3.029
338.2	67.5	32	5	0.071	4.857	19.402	19.402	0.208	0.071	8.881	12.737	0.751	0.156	0.358	0.033	4.727
335.7	70	32	5	0.071	5.035	18.937	18.937	0.203	0.071	9.059	13.071	0.748	0.152	0.338	0.032	4.750
333.2	72.5	38	5	0.073	5.215	21.957	21.957	0.241	0.073	9.239	13.407	0.745	0.180	0.317	0.030	6.000
330.7	75	32	5	0.071	5.395	18.063	18.063	0.193	0.071	9.419	13.743	0.742	0.143	0.297	0.028	5.107
328.2	77.5	41	5	0.074	5.576	22.618	22.618	0.251	0.074	9.600	14.080	0.739	0.185	0.277	0.026	7.115
325.7	80	11	12	0.062	5.746	5.942	7.683	0.093	0.062	9.770	14.406	0.737	0.069	0.257	0.025	2.760

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction



# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-03** **1000 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **38.95** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.190** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **5.6** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **33.25** FT. (Which is 3.99 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 2.112</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
403.2	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	4.456	4.456	1.820	0.253	0.884	0.109	ABO. WAT.
400.7	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	4.731	4.731	1.799	0.227	0.864	0.107	ABO. WAT.
398.2	7.5	2	50	0.102	0.839	2.522	8.026	0.096	0.049	4.929	5.041	1.784	0.171	0.844	0.107	NL
395.7	10	2	50	0.049	1.028	2.340	7.808	0.094	0.049	5.052	5.320	1.775	0.167	0.824	0.107	NL
393.2	12.5	3	50	0.052	1.154	3.401	9.081	0.105	0.052	5.178	5.602	1.767	0.186	0.803	0.107	NL
390.7	15	11	5	0.062	1.297	12.066	12.066	0.132	0.062	5.321	5.901	1.757	0.232	0.783	0.107	2.168
388.2	17.5	17	5	0.066	1.457	18.038	18.038	0.192	0.066	5.481	6.217	1.747	0.335	0.763	0.107	3.131
385.7	20	16	5	0.065	1.621	16.490	16.490	0.175	0.065	5.645	6.537	1.736	0.304	0.743	0.106	2.868
383.2	22.5	17	5	0.066	1.785	17.097	17.097	0.182	0.066	5.809	6.857	1.726	0.314	0.722	0.105	2.990
380.7	25	19	5	0.067	1.951	18.705	18.705	0.200	0.067	5.975	7.179	1.717	0.343	0.702	0.104	3.298
378.2	27.5	17	5	0.066	2.117	16.434	16.434	0.175	0.066	6.141	7.501	1.707	0.299	0.682	0.103	2.903
375.7	30	24	5	0.069	2.286	22.445	22.445	0.248	0.069	6.310	7.826	1.698	0.421	0.662	0.101	4.168
373.2	32.5	13	5	0.063	2.451	11.741	11.741	0.129	0.063	6.475	8.147	1.689	0.218	0.641	0.100	2.180
370.7	35	17	5	0.066	2.612	14.873	14.873	0.159	0.066	6.636	8.464	1.681	0.267	0.621	0.098	2.724
368.2	37.5	19	5	0.067	2.778	16.119	16.119	0.172	0.067	6.802	8.786	1.673	0.288	0.601	0.096	3.000
365.7	40	22	5	0.068	2.947	18.121	18.121	0.193	0.068	6.971	9.111	1.665	0.321	0.581	0.094	3.415
363.2	42.5	33	5	0.072	3.122	26.409	26.409	0.323	0.072	7.146	9.442	1.656	0.535	0.560	0.091	N60cs>25
360.7	45	20	5	0.067	3.296	15.577	15.577	0.166	0.067	7.320	9.772	1.648	0.274	0.540	0.089	3.079
358.2	47.5	23	5	0.068	3.465	17.471	17.471	0.186	0.068	7.489	10.097	1.641	0.305	0.520	0.087	3.506
355.7	50	25	5	0.069	3.636	18.539	18.539	0.198	0.069	7.660	10.424	1.633	0.323	0.500	0.084	3.845
353.2	52.5	35	5	0.072	3.812	25.348	25.348	0.299	0.072	7.836	10.756	1.626	0.486	0.479	0.081	N60cs>25
350.7	55	31	5	0.071	3.991	21.942	21.942	0.241	0.071	8.015	11.091	1.619	0.390	0.459	0.078	5.000
348.2	57.5	29	5	0.071	4.169	19.425	19.425	0.208	0.071	8.193	11.425	1.612	0.335	0.439	0.076	4.408
345.7	60	17	5	0.066	4.340	11.098	11.098	0.123	0.066	8.364	11.752	1.605	0.197	0.419	0.073	2.699
343.2	62.5	28	5	0.070	4.510	17.829	17.829	0.190	0.070	8.534	12.078	1.599	0.304	0.398	0.070	4.343
340.7	65	21	5	0.068	4.683	13.045	13.045	0.141	0.068	8.707	12.407	1.592	0.224	0.378	0.067	3.343
338.2	67.5	32	5	0.071	4.857	19.402	19.402	0.208	0.071	8.881	12.737	1.586	0.330	0.358	0.063	5.238
335.7	70	32	5	0.071	5.035	18.937	18.937	0.203	0.071	9.059	13.071	1.580	0.321	0.338	0.060	5.350
333.2	72.5	38	5	0.073	5.215	21.957	21.957	0.241	0.073	9.239	13.407	1.573	0.379	0.317	0.057	6.649
330.7	75	32	5	0.071	5.395	18.063	18.063	0.193	0.071	9.419	13.743	1.567	0.302	0.297	0.054	5.593
328.2	77.5	41	5	0.074	5.576	22.618	22.618	0.251	0.074	9.600	14.080	1.561	0.392	0.277	0.050	7.840
325.7	80	11	12	0.062	5.746	5.942	7.683	0.093	0.062	9.770	14.406	1.556	0.145	0.257	0.047	3.085

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-03** **2500 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **38.95** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.110** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.7** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **33.25** FT. (Which is 3.99 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 0.935</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
403.2	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	4.456	4.456	0.806	0.112	0.884	0.063	ABO. WAT.
400.7	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	4.731	4.731	0.796	0.100	0.864	0.062	ABO. WAT.
398.2	7.5	2	50	0.102	0.839	2.522	8.026	0.096	0.049	4.929	5.041	0.790	0.076	0.844	0.062	NL
395.7	10	2	50	0.049	1.028	2.340	7.808	0.094	0.049	5.052	5.320	0.786	0.074	0.824	0.062	NL
393.2	12.5	3	50	0.052	1.154	3.401	9.081	0.105	0.052	5.178	5.602	0.782	0.082	0.803	0.062	NL
390.7	15	11	5	0.062	1.297	12.066	12.066	0.132	0.062	5.321	5.901	0.778	0.103	0.783	0.062	1.661
388.2	17.5	17	5	0.066	1.457	18.038	18.038	0.192	0.066	5.481	6.217	0.773	0.148	0.763	0.062	2.387
385.7	20	16	5	0.065	1.621	16.490	16.490	0.175	0.065	5.645	6.537	0.769	0.135	0.743	0.062	2.177
383.2	22.5	17	5	0.066	1.785	17.097	17.097	0.182	0.066	5.809	6.857	0.764	0.139	0.722	0.061	2.279
380.7	25	19	5	0.067	1.951	18.705	18.705	0.200	0.067	5.975	7.179	0.760	0.152	0.702	0.060	2.533
378.2	27.5	17	5	0.066	2.117	16.434	16.434	0.175	0.066	6.141	7.501	0.756	0.132	0.682	0.060	2.200
375.7	30	24	5	0.069	2.286	22.445	22.445	0.248	0.069	6.310	7.826	0.752	0.186	0.662	0.059	3.153
373.2	32.5	13	5	0.063	2.451	11.741	11.741	0.129	0.063	6.475	8.147	0.748	0.096	0.641	0.058	1.655
370.7	35	17	5	0.066	2.612	14.873	14.873	0.159	0.066	6.636	8.464	0.744	0.118	0.621	0.057	2.070
368.2	37.5	19	5	0.067	2.778	16.119	16.119	0.172	0.067	6.802	8.786	0.741	0.127	0.601	0.056	2.268
365.7	40	22	5	0.068	2.947	18.121	18.121	0.193	0.068	6.971	9.111	0.737	0.142	0.581	0.054	2.630
363.2	42.5	33	5	0.072	3.122	26.409	26.409	0.323	0.072	7.146	9.442	0.733	0.237	0.560	0.053	N60cs>25
360.7	45	20	5	0.067	3.296	15.577	15.577	0.166	0.067	7.320	9.772	0.730	0.121	0.540	0.052	2.327
358.2	47.5	23	5	0.068	3.465	17.471	17.471	0.186	0.068	7.489	10.097	0.726	0.135	0.520	0.050	2.700
355.7	50	25	5	0.069	3.636	18.539	18.539	0.198	0.069	7.660	10.424	0.723	0.143	0.500	0.049	2.918
353.2	52.5	35	5	0.072	3.812	25.348	25.348	0.299	0.072	7.836	10.756	0.720	0.215	0.479	0.047	N60cs>25
350.7	55	31	5	0.071	3.991	21.942	21.942	0.241	0.071	8.015	11.091	0.717	0.173	0.459	0.045	3.844
348.2	57.5	29	5	0.071	4.169	19.425	19.425	0.208	0.071	8.193	11.425	0.713	0.148	0.439	0.044	3.364
345.7	60	17	5	0.066	4.340	11.098	11.098	0.123	0.066	8.364	11.752	0.711	0.087	0.419	0.042	2.071
343.2	62.5	28	5	0.070	4.510	17.829	17.829	0.190	0.070	8.534	12.078	0.708	0.135	0.398	0.040	3.375
340.7	65	21	5	0.068	4.683	13.045	13.045	0.141	0.068	8.707	12.407	0.705	0.099	0.378	0.039	2.538
338.2	67.5	32	5	0.071	4.857	19.402	19.402	0.208	0.071	8.881	12.737	0.702	0.146	0.358	0.037	3.946
335.7	70	32	5	0.071	5.035	18.937	18.937	0.203	0.071	9.059	13.071	0.699	0.142	0.338	0.035	4.057
333.2	72.5	38	5	0.073	5.215	21.957	21.957	0.241	0.073	9.239	13.407	0.697	0.168	0.317	0.033	5.091
330.7	75	32	5	0.071	5.395	18.063	18.063	0.193	0.071	9.419	13.743	0.694	0.134	0.297	0.031	4.323
328.2	77.5	41	5	0.074	5.576	22.618	22.618	0.251	0.074	9.600	14.080	0.691	0.173	0.277	0.029	5.966
325.7	80	11	12	0.062	5.746	5.942	7.683	0.093	0.062	9.770	14.406	0.689	0.064	0.257	0.027	2.370

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-03** **2500 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **38.95** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.270** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **6.0** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **33.25** FT. (Which is 3.99 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.770</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
403.2	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	4.456	4.456	1.526	0.212	0.884	0.155	ABO. WAT.
400.7	5	4	50	0.109	0.575	5.403	11.484	0.126	0.109	4.731	4.731	1.507	0.190	0.864	0.152	ABO. WAT.
398.2	7.5	2	50	0.102	0.839	2.522	8.026	0.096	0.049	4.929	5.041	1.495	0.144	0.844	0.151	NL
395.7	10	2	50	0.049	1.028	2.340	7.808	0.094	0.049	5.052	5.320	1.488	0.140	0.824	0.152	NL
393.2	12.5	3	50	0.052	1.154	3.401	9.081	0.105	0.052	5.178	5.602	1.480	0.155	0.803	0.152	NL
390.7	15	11	5	0.062	1.297	12.066	12.066	0.132	0.062	5.321	5.901	1.472	0.194	0.783	0.152	1.276
388.2	17.5	17	5	0.066	1.457	18.038	18.038	0.192	0.066	5.481	6.217	1.464	0.281	0.763	0.152	1.849
385.7	20	16	5	0.065	1.621	16.490	16.490	0.175	0.065	5.645	6.537	1.455	0.255	0.743	0.151	1.689
383.2	22.5	17	5	0.066	1.785	17.097	17.097	0.182	0.066	5.809	6.857	1.447	0.263	0.722	0.150	1.753
380.7	25	19	5	0.067	1.951	18.705	18.705	0.200	0.067	5.975	7.179	1.439	0.288	0.702	0.148	1.946
378.2	27.5	17	5	0.066	2.117	16.434	16.434	0.175	0.066	6.141	7.501	1.431	0.250	0.682	0.146	1.712
375.7	30	24	5	0.069	2.286	22.445	22.445	0.248	0.069	6.310	7.826	1.423	0.353	0.662	0.144	2.451
373.2	32.5	13	5	0.063	2.451	11.741	11.741	0.129	0.063	6.475	8.147	1.416	0.183	0.641	0.142	1.289
370.7	35	17	5	0.066	2.612	14.873	14.873	0.159	0.066	6.636	8.464	1.409	0.224	0.621	0.139	1.612
368.2	37.5	19	5	0.067	2.778	16.119	16.119	0.172	0.067	6.802	8.786	1.402	0.241	0.601	0.136	1.772
365.7	40	22	5	0.068	2.947	18.121	18.121	0.193	0.068	6.971	9.111	1.395	0.269	0.581	0.133	2.023
363.2	42.5	33	5	0.072	3.122	26.409	26.409	0.323	0.072	7.146	9.442	1.388	0.448	0.560	0.130	N60cs>25
360.7	45	20	5	0.067	3.296	15.577	15.577	0.166	0.067	7.320	9.772	1.381	0.229	0.540	0.127	1.803
358.2	47.5	23	5	0.068	3.465	17.471	17.471	0.186	0.068	7.489	10.097	1.375	0.256	0.520	0.123	2.081
355.7	50	25	5	0.069	3.636	18.539	18.539	0.198	0.069	7.660	10.424	1.369	0.271	0.500	0.119	2.277
353.2	52.5	35	5	0.072	3.812	25.348	25.348	0.299	0.072	7.836	10.756	1.363	0.408	0.479	0.115	N60cs>25
350.7	55	31	5	0.071	3.991	21.942	21.942	0.241	0.071	8.015	11.091	1.357	0.327	0.459	0.111	2.946
348.2	57.5	29	5	0.071	4.169	19.425	19.425	0.208	0.071	8.193	11.425	1.351	0.281	0.439	0.107	2.626
345.7	60	17	5	0.066	4.340	11.098	11.098	0.123	0.066	8.364	11.752	1.345	0.165	0.419	0.103	1.602
343.2	62.5	28	5	0.070	4.510	17.829	17.829	0.190	0.070	8.534	12.078	1.340	0.255	0.398	0.099	2.576
340.7	65	21	5	0.068	4.683	13.045	13.045	0.141	0.068	8.707	12.407	1.334	0.188	0.378	0.095	1.979
338.2	67.5	32	5	0.071	4.857	19.402	19.402	0.208	0.071	8.881	12.737	1.329	0.276	0.358	0.090	3.067
335.7	70	32	5	0.071	5.035	18.937	18.937	0.203	0.071	9.059	13.071	1.324	0.269	0.338	0.086	3.128
333.2	72.5	38	5	0.073	5.215	21.957	21.957	0.241	0.073	9.239	13.407	1.319	0.318	0.317	0.081	3.926
330.7	75	32	5	0.071	5.395	18.063	18.063	0.193	0.071	9.419	13.743	1.314	0.254	0.297	0.076	3.342
328.2	77.5	41	5	0.074	5.576	22.618	22.618	0.251	0.074	9.600	14.080	1.309	0.329	0.277	0.071	4.634
325.7	80	11	12	0.062	5.746	5.942	7.683	0.093	0.062	9.770	14.406	1.304	0.121	0.257	0.067	1.806

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-04 1000 Long period  
 ELEVATION OF BORING GROUND SURFACE ===== 405.40 FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 37.49 FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.100 Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 7.5 Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 32.09 FT. (Which is 3.8508 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor	(K $\alpha$ )= 1.00
Earthquake Magnitude Scaling Factor	(MSF)= 1.000

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K $\sigma$ )(K $\alpha$ )(MSF)					
402.9	2.5	7	50	0.115	0.300	9.190	16.028	0.171	0.115	4.302	4.302	0.868	0.148	0.894	0.058	ABO. WAT.	
400.4	5	2	50	0.102	0.571	2.701	8.241	0.098	0.102	4.573	4.573	0.857	0.084	0.874	0.057	ABO. WAT.	
397.9	7.5	2	50	0.102	0.826	2.541	8.049	0.096	0.049	4.762	4.893	0.851	0.082	0.853	0.057	NL	
395.4	10	6	35	0.057	1.025	7.031	13.437	0.145	0.057	4.895	5.182	0.846	0.123	0.833	0.057	2.158	
392.9	12.5	4	50	0.054	1.164	4.515	10.418	0.117	0.054	5.034	5.477	0.841	0.098	0.813	0.057	NL	
390.4	15	7	35	0.058	1.304	7.658	14.190	0.152	0.058	5.174	5.773	0.837	0.127	0.793	0.058	2.190	
387.9	17.5	26	6	0.070	1.464	27.521	27.680	0.359	0.070	5.334	6.089	0.831	0.298	0.772	0.057	N60cs>25	
385.4	20	14	6	0.064	1.632	14.380	14.477	0.155	0.064	5.502	6.413	0.826	0.128	0.752	0.057	2.246	
382.9	22.5	6	35	0.057	1.783	6.038	12.246	0.133	0.057	5.653	6.720	0.822	0.109	0.732	0.057	1.912	
380.4	25	18	6	0.066	1.937	17.785	17.898	0.191	0.066	5.807	7.030	0.817	0.156	0.712	0.056	2.786	
377.9	27.5	16	6	0.065	2.101	15.526	15.629	0.166	0.065	5.971	7.350	0.813	0.135	0.691	0.055	2.455	
375.4	30	19	6	0.067	2.266	17.847	17.960	0.191	0.067	6.136	7.671	0.809	0.155	0.671	0.055	2.818	
372.9	32.5	26	6	0.070	2.437	23.550	23.690	0.268	0.070	6.307	7.998	0.804	0.215	0.651	0.054	3.981	
370.4	35	18	6	0.066	2.607	15.763	15.867	0.169	0.066	6.477	8.324	0.800	0.135	0.631	0.053	2.547	
367.9	37.5	11	6	0.062	2.767	9.351	9.425	0.108	0.062	6.637	8.640	0.796	0.086	0.610	0.052	1.654	
365.4	40	19	6	0.067	2.928	15.701	15.804	0.168	0.067	6.798	8.957	0.792	0.133	0.590	0.051	2.608	
362.9	42.5	19	6	0.067	3.096	15.269	15.370	0.164	0.067	6.966	9.281	0.788	0.129	0.570	0.049	2.633	
360.4	45	12	6	0.063	3.259	9.399	9.473	0.109	0.063	7.129	9.600	0.785	0.086	0.550	0.048	1.792	
357.9	47.5	24	6	0.069	3.424	18.340	18.456	0.197	0.069	7.294	9.921	0.781	0.154	0.529	0.047	3.277	
355.4	50	20	6	0.067	3.594	14.917	15.017	0.160	0.067	7.464	10.247	0.777	0.124	0.509	0.045	2.756	
352.9	52.5	17	6	0.066	3.760	12.397	12.485	0.136	0.066	7.630	10.569	0.774	0.105	0.489	0.044	2.386	
350.4	55	25	6	0.069	3.929	17.834	17.947	0.191	0.069	7.799	10.894	0.771	0.147	0.469	0.043	3.419	
347.9	57.5	34	6	0.072	4.105	22.998	23.136	0.259	0.072	7.975	11.226	0.767	0.199	0.448	0.041	4.854	
345.4	60	20	6	0.067	4.279	13.176	13.268	0.143	0.067	8.149	11.556	0.764	0.109	0.428	0.039	2.795	
342.9	62.5	29	6	0.071	4.452	18.622	18.739	0.200	0.071	8.322	11.885	0.761	0.152	0.408	0.038	4.000	
340.4	65	18	6	0.066	4.623	11.277	11.360	0.125	0.066	8.493	12.212	0.758	0.095	0.388	0.036	2.639	
337.9	67.5	36	6	0.073	4.797	22.009	22.142	0.244	0.073	8.667	12.542	0.755	0.184	0.367	0.035	5.257	
335.4	70	19	6	0.067	4.972	11.340	11.423	0.126	0.067	8.842	12.873	0.752	0.095	0.347	0.033	2.879	
332.9	72.5	8	6	0.059	5.130	4.675	4.727	0.070	0.059	9.000	13.187	0.749	0.052	0.327	0.031	1.677	
330.4	75	27	6	0.070	5.291	15.447	15.549	0.166	0.070	9.161	13.504	0.746	0.124	0.307	0.029	4.276	
327.9	77.5	42	6	0.074	5.471	23.479	23.619	0.267	0.074	9.341	13.840	0.743	0.198	0.286	0.028	7.071	
325.4	80	12	12	0.063	5.642	6.566	8.327	0.099	0.063	9.512	14.167	0.741	0.073	0.266	0.026	2.808	

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-04 **1000 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== 405.40 FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 37.49 FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.190 Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 5.6 Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 32.09 FT. (Which is 3.8508 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 2.112</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
402.9	2.5	7	50	0.115	0.300	9.190	16.028	0.171	0.115	4.302	4.302	1.833	0.313	0.894	0.110	ABO. WAT.
400.4	5	2	50	0.102	0.571	2.701	8.241	0.098	0.102	4.573	4.573	1.811	0.177	0.874	0.108	ABO. WAT.
397.9	7.5	2	50	0.102	0.826	2.541	8.049	0.096	0.049	4.762	4.893	1.796	0.172	0.853	0.108	NL
395.4	10	6	35	0.057	1.025	7.031	13.437	0.145	0.057	4.895	5.182	1.787	0.259	0.833	0.109	2.376
392.9	12.5	4	50	0.054	1.164	4.515	10.418	0.117	0.054	5.034	5.477	1.777	0.208	0.813	0.109	NL
390.4	15	7	35	0.058	1.304	7.658	14.190	0.152	0.058	5.174	5.773	1.767	0.269	0.793	0.109	2.468
387.9	17.5	26	6	0.070	1.464	27.521	27.680	0.359	0.070	5.334	6.089	1.756	0.630	0.772	0.109	N60cs>25
385.4	20	14	6	0.064	1.632	14.380	14.477	0.155	0.064	5.502	6.413	1.745	0.270	0.752	0.108	2.500
382.9	22.5	6	35	0.057	1.783	6.038	12.246	0.133	0.057	5.653	6.720	1.736	0.231	0.732	0.107	2.159
380.4	25	18	6	0.066	1.937	17.785	17.898	0.191	0.066	5.807	7.030	1.727	0.330	0.712	0.106	3.113
377.9	27.5	16	6	0.065	2.101	15.526	15.629	0.166	0.065	5.971	7.350	1.717	0.285	0.691	0.105	2.714
375.4	30	19	6	0.067	2.266	17.847	17.960	0.191	0.067	6.136	7.671	1.708	0.326	0.671	0.104	3.135
372.9	32.5	26	6	0.070	2.437	23.550	23.690	0.268	0.070	6.307	7.998	1.698	0.455	0.651	0.102	4.461
370.4	35	18	6	0.066	2.607	15.763	15.867	0.169	0.066	6.477	8.324	1.689	0.285	0.631	0.100	2.850
367.9	37.5	11	6	0.062	2.767	9.351	9.425	0.108	0.062	6.637	8.640	1.681	0.182	0.610	0.098	1.857
365.4	40	19	6	0.067	2.928	15.701	15.804	0.168	0.067	6.798	8.957	1.673	0.281	0.590	0.096	2.927
362.9	42.5	19	6	0.067	3.096	15.269	15.370	0.164	0.067	6.966	9.281	1.665	0.273	0.570	0.094	2.904
360.4	45	12	6	0.063	3.259	9.399	9.473	0.109	0.063	7.129	9.600	1.657	0.181	0.550	0.091	1.989
357.9	47.5	24	6	0.069	3.424	18.340	18.456	0.197	0.069	7.294	9.921	1.650	0.325	0.529	0.089	3.652
355.4	50	20	6	0.067	3.594	14.917	15.017	0.160	0.067	7.464	10.247	1.642	0.263	0.509	0.086	3.058
352.9	52.5	17	6	0.066	3.760	12.397	12.485	0.136	0.066	7.630	10.569	1.635	0.222	0.489	0.084	2.643
350.4	55	25	6	0.069	3.929	17.834	17.947	0.191	0.069	7.799	10.894	1.628	0.311	0.469	0.081	3.840
347.9	57.5	34	6	0.072	4.105	22.998	23.136	0.259	0.072	7.975	11.226	1.620	0.420	0.448	0.078	5.385
345.4	60	20	6	0.067	4.279	13.176	13.268	0.143	0.067	8.149	11.556	1.613	0.231	0.428	0.075	3.080
342.9	62.5	29	6	0.071	4.452	18.622	18.739	0.200	0.071	8.322	11.885	1.607	0.321	0.408	0.072	4.458
340.4	65	18	6	0.066	4.623	11.277	11.360	0.125	0.066	8.493	12.212	1.600	0.200	0.388	0.069	2.899
337.9	67.5	36	6	0.073	4.797	22.009	22.142	0.244	0.073	8.667	12.542	1.594	0.389	0.367	0.066	5.894
335.4	70	19	6	0.067	4.972	11.340	11.423	0.126	0.067	8.842	12.873	1.587	0.200	0.347	0.062	3.226
332.9	72.5	8	6	0.059	5.130	4.675	4.727	0.070	0.059	9.000	13.187	1.582	0.111	0.327	0.059	1.881
330.4	75	27	6	0.070	5.291	15.447	15.549	0.166	0.070	9.161	13.504	1.576	0.262	0.307	0.056	4.679
327.9	77.5	42	6	0.074	5.471	23.479	23.619	0.267	0.074	9.341	13.840	1.570	0.419	0.286	0.052	8.058
325.4	80	12	12	0.063	5.642	6.566	8.327	0.099	0.063	9.512	14.167	1.564	0.155	0.266	0.049	3.163

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-04** **2500 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.40** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **37.49** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.110** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.7** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **32.09** FT. (Which is 3.8508 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)=</b> 1.00
Earthquake Magnitude Scaling Factor <b>(MSF)=</b> 0.935

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
402.9	2.5	7	50	0.115	0.300	9.190	16.028	0.171	0.115	4.302	4.302	0.812	0.139	0.894	0.064	ABO. WAT.
400.4	5	2	50	0.102	0.571	2.701	8.241	0.098	0.102	4.573	4.573	0.802	0.079	0.874	0.062	ABO. WAT.
397.9	7.5	2	50	0.102	0.826	2.541	8.049	0.096	0.049	4.762	4.893	0.795	0.076	0.853	0.063	NL
395.4	10	6	35	0.057	1.025	7.031	13.437	0.145	0.057	4.895	5.182	0.791	0.115	0.833	0.063	1.825
392.9	12.5	4	50	0.054	1.164	4.515	10.418	0.117	0.054	5.034	5.477	0.786	0.092	0.813	0.063	NL
390.4	15	7	35	0.058	1.304	7.658	14.190	0.152	0.058	5.174	5.773	0.782	0.119	0.793	0.063	1.889
387.9	17.5	26	6	0.070	1.464	27.521	27.680	0.359	0.070	5.334	6.089	0.777	0.279	0.772	0.063	N60cs>25
385.4	20	14	6	0.064	1.632	14.380	14.477	0.155	0.064	5.502	6.413	0.773	0.120	0.752	0.063	1.905
382.9	22.5	6	35	0.057	1.783	6.038	12.246	0.133	0.057	5.653	6.720	0.768	0.102	0.732	0.062	1.645
380.4	25	18	6	0.066	1.937	17.785	17.898	0.191	0.066	5.807	7.030	0.764	0.146	0.712	0.062	2.355
377.9	27.5	16	6	0.065	2.101	15.526	15.629	0.166	0.065	5.971	7.350	0.760	0.126	0.691	0.061	2.066
375.4	30	19	6	0.067	2.266	17.847	17.960	0.191	0.067	6.136	7.671	0.756	0.144	0.671	0.060	2.400
372.9	32.5	26	6	0.070	2.437	23.550	23.690	0.268	0.070	6.307	7.998	0.752	0.202	0.651	0.059	3.424
370.4	35	18	6	0.066	2.607	15.763	15.867	0.169	0.066	6.477	8.324	0.748	0.126	0.631	0.058	2.172
367.9	37.5	11	6	0.062	2.767	9.351	9.425	0.108	0.062	6.637	8.640	0.744	0.080	0.610	0.057	1.404
365.4	40	19	6	0.067	2.928	15.701	15.804	0.168	0.067	6.798	8.957	0.741	0.124	0.590	0.056	2.214
362.9	42.5	19	6	0.067	3.096	15.269	15.370	0.164	0.067	6.966	9.281	0.737	0.121	0.570	0.054	2.241
360.4	45	12	6	0.063	3.259	9.399	9.473	0.109	0.063	7.129	9.600	0.734	0.080	0.550	0.053	1.509
357.9	47.5	24	6	0.069	3.424	18.340	18.456	0.197	0.069	7.294	9.921	0.730	0.144	0.529	0.051	2.824
355.4	50	20	6	0.067	3.594	14.917	15.017	0.160	0.067	7.464	10.247	0.727	0.116	0.509	0.050	2.320
352.9	52.5	17	6	0.066	3.760	12.397	12.485	0.136	0.066	7.630	10.569	0.724	0.098	0.489	0.048	2.042
350.4	55	25	6	0.069	3.929	17.834	17.947	0.191	0.069	7.799	10.894	0.721	0.138	0.469	0.047	2.936
347.9	57.5	34	6	0.072	4.105	22.998	23.136	0.259	0.072	7.975	11.226	0.717	0.186	0.448	0.045	4.133
345.4	60	20	6	0.067	4.279	13.176	13.268	0.143	0.067	8.149	11.556	0.714	0.102	0.428	0.043	2.372
342.9	62.5	29	6	0.071	4.452	18.622	18.739	0.200	0.071	8.322	11.885	0.711	0.142	0.408	0.042	3.381
340.4	65	18	6	0.066	4.623	11.277	11.360	0.125	0.066	8.493	12.212	0.708	0.089	0.388	0.040	2.225
337.9	67.5	36	6	0.073	4.797	22.009	22.142	0.244	0.073	8.667	12.542	0.706	0.172	0.367	0.038	4.526
335.4	70	19	6	0.067	4.972	11.340	11.423	0.126	0.067	8.842	12.873	0.703	0.089	0.347	0.036	2.472
332.9	72.5	8	6	0.059	5.130	4.675	4.727	0.070	0.059	9.000	13.187	0.700	0.049	0.327	0.034	1.441
330.4	75	27	6	0.070	5.291	15.447	15.549	0.166	0.070	9.161	13.504	0.698	0.116	0.307	0.032	3.625
327.9	77.5	42	6	0.074	5.471	23.479	23.619	0.267	0.074	9.341	13.840	0.695	0.186	0.286	0.030	6.200
325.4	80	12	12	0.063	5.642	6.566	8.327	0.099	0.063	9.512	14.167	0.693	0.069	0.266	0.028	2.464

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-04** **2500 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.40** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **37.49** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.270** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **6.0** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **32.09** FT. (Which is 3.8508 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>σ</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.770</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
402.9	2.5	7	50	0.115	0.300	9.190	16.028	0.171	0.115	4.302	4.302	1.536	<b>0.263</b>	0.894	<b>0.157</b>	<b>ABO. WAT.</b>
400.4	5	2	50	0.102	0.571	2.701	8.241	0.098	0.102	4.573	4.573	1.518	<b>0.149</b>	0.874	<b>0.153</b>	<b>ABO. WAT.</b>
397.9	7.5	2	50	0.102	0.826	2.541	8.049	0.096	0.049	4.762	4.893	1.506	<b>0.145</b>	0.853	<b>0.154</b>	<b>NL</b>
395.4	10	6	35	0.057	1.025	7.031	13.437	0.145	0.057	4.895	5.182	1.497	<b>0.217</b>	0.833	<b>0.155</b>	<b>1.400</b>
392.9	12.5	4	50	0.054	1.164	4.515	10.418	0.117	0.054	5.034	5.477	1.489	<b>0.174</b>	0.813	<b>0.155</b>	<b>NL</b>
390.4	15	7	35	0.058	1.304	7.658	14.190	0.152	0.058	5.174	5.773	1.481	<b>0.225</b>	0.793	<b>0.155</b>	<b>1.452</b>
387.9	17.5	26	6	0.070	1.464	27.521	27.680	0.359	0.070	5.334	6.089	1.472	<b>0.528</b>	0.772	<b>0.155</b>	<b>N60cs&gt;25</b>
385.4	20	14	6	0.064	1.632	14.380	14.477	0.155	0.064	5.502	6.413	1.463	<b>0.227</b>	0.752	<b>0.154</b>	<b>1.474</b>
382.9	22.5	6	35	0.057	1.783	6.038	12.246	0.133	0.057	5.653	6.720	1.455	<b>0.194</b>	0.732	<b>0.153</b>	<b>1.268</b>
380.4	25	18	6	0.066	1.937	17.785	17.898	0.191	0.066	5.807	7.030	1.447	<b>0.276</b>	0.712	<b>0.151</b>	<b>1.828</b>
377.9	27.5	16	6	0.065	2.101	15.526	15.629	0.166	0.065	5.971	7.350	1.439	<b>0.239</b>	0.691	<b>0.149</b>	<b>1.604</b>
375.4	30	19	6	0.067	2.266	17.847	17.960	0.191	0.067	6.136	7.671	1.431	<b>0.273</b>	0.671	<b>0.147</b>	<b>1.857</b>
372.9	32.5	26	6	0.070	2.437	23.550	23.690	0.268	0.070	6.307	7.998	1.423	<b>0.381</b>	0.651	<b>0.145</b>	<b>2.628</b>
370.4	35	18	6	0.066	2.607	15.763	15.867	0.169	0.066	6.477	8.324	1.416	<b>0.239</b>	0.631	<b>0.142</b>	<b>1.683</b>
367.9	37.5	11	6	0.062	2.767	9.351	9.425	0.108	0.062	6.637	8.640	1.409	<b>0.152</b>	0.610	<b>0.139</b>	<b>1.094</b>
365.4	40	19	6	0.067	2.928	15.701	15.804	0.168	0.067	6.798	8.957	1.402	<b>0.236</b>	0.590	<b>0.136</b>	<b>1.735</b>
362.9	42.5	19	6	0.067	3.096	15.269	15.370	0.164	0.067	6.966	9.281	1.395	<b>0.229</b>	0.570	<b>0.133</b>	<b>1.722</b>
360.4	45	12	6	0.063	3.259	9.399	9.473	0.109	0.063	7.129	9.600	1.389	<b>0.151</b>	0.550	<b>0.130</b>	<b>1.162</b>
357.9	47.5	24	6	0.069	3.424	18.340	18.456	0.197	0.069	7.294	9.921	1.382	<b>0.272</b>	0.529	<b>0.126</b>	<b>2.159</b>
355.4	50	20	6	0.067	3.594	14.917	15.017	0.160	0.067	7.464	10.247	1.376	<b>0.220</b>	0.509	<b>0.123</b>	<b>1.789</b>
352.9	52.5	17	6	0.066	3.760	12.397	12.485	0.136	0.066	7.630	10.569	1.370	<b>0.186</b>	0.489	<b>0.119</b>	<b>1.563</b>
350.4	55	25	6	0.069	3.929	17.834	17.947	0.191	0.069	7.799	10.894	1.364	<b>0.261</b>	0.469	<b>0.115</b>	<b>2.270</b>
347.9	57.5	34	6	0.072	4.105	22.998	23.136	0.259	0.072	7.975	11.226	1.358	<b>0.352</b>	0.448	<b>0.111</b>	<b>3.171</b>
345.4	60	20	6	0.067	4.279	13.176	13.268	0.143	0.067	8.149	11.556	1.352	<b>0.193</b>	0.428	<b>0.107</b>	<b>1.804</b>
342.9	62.5	29	6	0.071	4.452	18.622	18.739	0.200	0.071	8.322	11.885	1.346	<b>0.269</b>	0.408	<b>0.102</b>	<b>2.637</b>
340.4	65	18	6	0.066	4.623	11.277	11.360	0.125	0.066	8.493	12.212	1.341	<b>0.168</b>	0.388	<b>0.098</b>	<b>1.714</b>
337.9	67.5	36	6	0.073	4.797	22.009	22.142	0.244	0.073	8.667	12.542	1.336	<b>0.326</b>	0.367	<b>0.093</b>	<b>3.505</b>
335.4	70	19	6	0.067	4.972	11.340	11.423	0.126	0.067	8.842	12.873	1.330	<b>0.168</b>	0.347	<b>0.089</b>	<b>1.888</b>
332.9	72.5	8	6	0.059	5.130	4.675	4.727	0.070	0.059	9.000	13.187	1.326	<b>0.093</b>	0.327	<b>0.084</b>	<b>1.107</b>
330.4	75	27	6	0.070	5.291	15.447	15.549	0.166	0.070	9.161	13.504	1.321	<b>0.219</b>	0.307	<b>0.079</b>	<b>2.772</b>
327.9	77.5	42	6	0.074	5.471	23.479	23.619	0.267	0.074	9.341	13.840	1.316	<b>0.351</b>	0.286	<b>0.074</b>	<b>4.743</b>
325.4	80	12	12	0.063	5.642	6.566	8.327	0.099	0.063	9.512	14.167	1.311	<b>0.130</b>	0.266	<b>0.070</b>	<b>1.857</b>

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-05** **1000 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **35.99** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.100** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.5** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **30.29** FT. (Which is 3.6348 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.000</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> )60	Fines Content Corrected (N <sub>1</sub> )60cs	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
403.2	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	4.101	4.101	0.876	0.136	0.908	0.059	ABO. WAT.	
400.7	5	4	50	0.109	0.578	5.403	11.484	0.126	0.109	4.379	4.379	0.865	0.109	0.888	0.058	ABO. WAT.	
398.2	7.5	4	50	0.109	0.851	5.008	11.010	0.122	0.054	4.583	4.695	0.857	0.105	0.868	0.058	NL	
395.7	10	3	50	0.052	1.052	3.470	9.164	0.106	0.052	4.716	4.984	0.852	0.090	0.848	0.058	NL	
393.2	12.5	8	35	0.059	1.191	8.927	15.712	0.167	0.059	4.855	5.279	0.847	0.141	0.827	0.058	2.431	
390.7	15	9	35	0.060	1.340	9.713	16.656	0.177	0.060	5.004	5.584	0.842	0.149	0.807	0.059	2.525	
388.2	17.5	13	6	0.063	1.494	13.622	13.716	0.147	0.063	5.158	5.894	0.837	0.123	0.787	0.058	2.121	
385.7	20	13	6	0.063	1.652	13.272	13.364	0.144	0.063	5.316	6.208	0.832	0.120	0.767	0.058	2.069	
383.2	22.5	24	6	0.069	1.817	23.923	24.065	0.275	0.069	5.481	6.529	0.827	0.227	0.746	0.058	3.914	
380.7	25	19	6	0.067	1.987	18.535	18.652	0.199	0.067	5.651	6.855	0.822	0.164	0.726	0.057	2.877	
378.2	27.5	24	6	0.069	2.157	22.985	23.123	0.259	0.069	5.821	7.181	0.817	0.212	0.706	0.057	3.719	
375.7	30	14	6	0.064	2.323	12.988	13.079	0.141	0.064	5.987	7.503	0.813	0.115	0.686	0.056	2.054	
373.2	32.5	20	6	0.067	2.487	17.933	18.047	0.192	0.067	6.151	7.823	0.808	0.155	0.665	0.055	2.818	
370.7	35	17	6	0.066	2.653	14.758	14.857	0.159	0.066	6.317	8.145	0.804	0.128	0.645	0.054	2.370	
368.2	37.5	23	6	0.068	2.821	19.363	19.484	0.209	0.068	6.485	8.469	0.800	0.167	0.625	0.053	3.151	
365.7	40	23	6	0.068	2.991	18.805	18.923	0.202	0.068	6.655	8.795	0.795	0.161	0.605	0.052	3.096	
363.2	42.5	14	4	0.064	3.156	11.143	11.143	0.123	0.064	6.820	9.116	0.792	0.097	0.584	0.051	1.902	
360.7	45	19	4	0.067	3.320	14.745	14.745	0.158	0.067	6.984	9.436	0.788	0.125	0.564	0.050	2.500	
358.2	47.5	13	4	0.063	3.483	9.850	9.850	0.112	0.063	7.147	9.755	0.784	0.088	0.544	0.048	1.833	
355.7	50	20	12	0.067	3.646	14.811	16.832	0.179	0.067	7.310	10.074	0.781	0.140	0.524	0.047	2.979	
353.2	52.5	24	6	0.069	3.816	17.372	17.483	0.186	0.069	7.480	10.400	0.777	0.145	0.503	0.045	3.222	
350.7	55	25	6	0.069	3.989	17.699	17.812	0.190	0.069	7.653	10.729	0.774	0.147	0.483	0.044	3.341	
348.2	57.5	31	6	0.071	4.164	20.780	20.907	0.227	0.071	7.828	11.060	0.770	0.175	0.463	0.043	4.070	
345.7	60	32	6	0.071	4.342	20.884	21.012	0.228	0.071	8.006	11.394	0.767	0.175	0.443	0.041	4.268	
343.2	62.5	54	6	0.076	4.526	34.306	34.497	1.000	0.076	8.190	11.734	0.763	0.763	0.422	0.039	N60cs>25	
340.7	65	27	6	0.070	4.709	16.711	16.819	0.179	0.070	8.373	12.073	0.760	0.136	0.402	0.038	3.579	
338.2	67.5	38	6	0.073	4.888	22.942	23.079	0.258	0.073	8.552	12.408	0.757	0.195	0.382	0.036	5.417	
335.7	70	34	6	0.072	5.069	20.029	20.153	0.217	0.072	8.733	12.745	0.753	0.163	0.362	0.034	4.794	
333.2	72.5	62	6	0.078	5.257	35.628	35.825	1.000	0.078	8.921	13.089	0.750	0.750	0.341	0.033	N60cs>25	
330.7	75	20	6	0.067	5.438	11.227	11.309	0.125	0.067	9.102	13.426	0.747	0.093	0.321	0.031	3.000	
328.2	77.5	41	6	0.074	5.614	22.511	22.646	0.252	0.074	9.278	13.758	0.744	0.187	0.301	0.029	6.448	
325.7	80	16	12	0.065	5.788	8.598	10.423	0.117	0.065	9.452	14.088	0.742	0.087	0.281	0.027	3.222	

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction



# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-05** **1000 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **35.99** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.190** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **5.6** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **30.29** FT. (Which is 3.6348 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 2.112</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> )60	Fines Content Corrected (N <sub>1</sub> )60cs	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
403.2	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	4.101	4.101	1.851	0.287	0.908	0.112	ABO. WAT.
400.7	5	4	50	0.109	0.578	5.403	11.484	0.126	0.109	4.379	4.379	1.827	0.230	0.888	0.110	ABO. WAT.
398.2	7.5	4	50	0.109	0.851	5.008	11.010	0.122	0.054	4.583	4.695	1.810	0.221	0.868	0.110	NL
395.7	10	3	50	0.052	1.052	3.470	9.164	0.106	0.052	4.716	4.984	1.800	0.191	0.848	0.111	NL
393.2	12.5	8	35	0.059	1.191	8.927	15.712	0.167	0.059	4.855	5.279	1.789	0.299	0.827	0.111	2.694
390.7	15	9	35	0.060	1.340	9.713	16.656	0.177	0.060	5.004	5.584	1.779	0.315	0.807	0.111	2.838
388.2	17.5	13	6	0.063	1.494	13.622	13.716	0.147	0.063	5.158	5.894	1.768	0.260	0.787	0.111	2.342
385.7	20	13	6	0.063	1.652	13.272	13.364	0.144	0.063	5.316	6.208	1.757	0.253	0.767	0.111	2.279
383.2	22.5	24	6	0.069	1.817	23.923	24.065	0.275	0.069	5.481	6.529	1.747	0.480	0.746	0.110	4.364
380.7	25	19	6	0.067	1.987	18.535	18.652	0.199	0.067	5.651	6.855	1.736	0.345	0.726	0.109	3.165
378.2	27.5	24	6	0.069	2.157	22.985	23.123	0.259	0.069	5.821	7.181	1.726	0.447	0.706	0.108	4.139
375.7	30	14	6	0.064	2.323	12.988	13.079	0.141	0.064	5.987	7.503	1.716	0.242	0.686	0.106	2.283
373.2	32.5	20	6	0.067	2.487	17.933	18.047	0.192	0.067	6.151	7.823	1.707	0.328	0.665	0.104	3.154
370.7	35	17	6	0.066	2.653	14.758	14.857	0.159	0.066	6.317	8.145	1.698	0.270	0.645	0.103	2.621
368.2	37.5	23	6	0.068	2.821	19.363	19.484	0.209	0.068	6.485	8.469	1.689	0.353	0.625	0.101	3.495
365.7	40	23	6	0.068	2.991	18.805	18.923	0.202	0.068	6.655	8.795	1.680	0.339	0.605	0.099	3.424
363.2	42.5	14	4	0.064	3.156	11.143	11.143	0.123	0.064	6.820	9.116	1.672	0.206	0.584	0.096	2.146
360.7	45	19	4	0.067	3.320	14.745	14.745	0.158	0.067	6.984	9.436	1.664	0.263	0.564	0.094	2.798
358.2	47.5	13	4	0.063	3.483	9.850	9.850	0.112	0.063	7.147	9.755	1.656	0.185	0.544	0.092	2.011
355.7	50	20	12	0.067	3.646	14.811	16.832	0.179	0.067	7.310	10.074	1.649	0.295	0.524	0.089	3.315
353.2	52.5	24	6	0.069	3.816	17.372	17.483	0.186	0.069	7.480	10.400	1.641	0.305	0.503	0.086	3.547
350.7	55	25	6	0.069	3.989	17.699	17.812	0.190	0.069	7.653	10.729	1.634	0.310	0.483	0.084	3.690
348.2	57.5	31	6	0.071	4.164	20.780	20.907	0.227	0.071	7.828	11.060	1.626	0.369	0.463	0.081	4.556
345.7	60	32	6	0.071	4.342	20.884	21.012	0.228	0.071	8.006	11.394	1.619	0.369	0.443	0.078	4.731
343.2	62.5	54	6	0.076	4.526	34.306	34.497	1.000	0.076	8.190	11.734	1.612	1.612	0.422	0.075	N60cs>25
340.7	65	27	6	0.070	4.709	16.711	16.819	0.179	0.070	8.373	12.073	1.605	0.287	0.402	0.072	3.986
338.2	67.5	38	6	0.073	4.888	22.942	23.079	0.258	0.073	8.552	12.408	1.598	0.412	0.382	0.068	6.059
335.7	70	34	6	0.072	5.069	20.029	20.153	0.217	0.072	8.733	12.745	1.591	0.345	0.362	0.065	5.308
333.2	72.5	62	6	0.078	5.257	35.628	35.825	1.000	0.078	8.921	13.089	1.584	1.584	0.341	0.062	N60cs>25
330.7	75	20	6	0.067	5.438	11.227	11.309	0.125	0.067	9.102	13.426	1.578	0.197	0.321	0.058	3.397
328.2	77.5	41	6	0.074	5.614	22.511	22.646	0.252	0.074	9.278	13.758	1.572	0.396	0.301	0.055	7.200
325.7	80	16	12	0.065	5.788	8.598	10.423	0.117	0.065	9.452	14.088	1.566	0.183	0.281	0.052	3.519

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-05 2500 Long period  
 ELEVATION OF BORING GROUND SURFACE ===== 405.70 FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 35.99 FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.110 Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 7.7 Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 30.29 FT. (Which is 3.6348 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)=</b> 1.00
Earthquake Magnitude Scaling Factor <b>(MSF)=</b> 0.935

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
403.2	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	4.101	4.101	0.819	0.127	0.908	0.065	ABO. WAT.
400.7	5	4	50	0.109	0.578	5.403	11.484	0.126	0.109	4.379	4.379	0.809	0.102	0.888	0.063	ABO. WAT.
398.2	7.5	4	50	0.109	0.851	5.008	11.010	0.122	0.054	4.583	4.695	0.801	0.098	0.868	0.064	NL
395.7	10	3	50	0.052	1.052	3.470	9.164	0.106	0.052	4.716	4.984	0.797	0.084	0.848	0.064	NL
393.2	12.5	8	35	0.059	1.191	8.927	15.712	0.167	0.059	4.855	5.279	0.792	0.132	0.827	0.064	2.063
390.7	15	9	35	0.060	1.340	9.713	16.656	0.177	0.060	5.004	5.584	0.787	0.139	0.807	0.064	2.172
388.2	17.5	13	6	0.063	1.494	13.622	13.716	0.147	0.063	5.158	5.894	0.783	0.115	0.787	0.064	1.797
385.7	20	13	6	0.063	1.652	13.272	13.364	0.144	0.063	5.316	6.208	0.778	0.112	0.767	0.064	1.750
383.2	22.5	24	6	0.069	1.817	23.923	24.065	0.275	0.069	5.481	6.529	0.773	0.213	0.746	0.064	3.328
380.7	25	19	6	0.067	1.987	18.535	18.652	0.199	0.067	5.651	6.855	0.769	0.153	0.726	0.063	2.429
378.2	27.5	24	6	0.069	2.157	22.985	23.123	0.259	0.069	5.821	7.181	0.764	0.198	0.706	0.062	3.194
375.7	30	14	6	0.064	2.323	12.988	13.079	0.141	0.064	5.987	7.503	0.760	0.107	0.686	0.061	1.754
373.2	32.5	20	6	0.067	2.487	17.933	18.047	0.192	0.067	6.151	7.823	0.756	0.145	0.665	0.060	2.417
370.7	35	17	6	0.066	2.653	14.758	14.857	0.159	0.066	6.317	8.145	0.752	0.120	0.645	0.059	2.034
368.2	37.5	23	6	0.068	2.821	19.363	19.484	0.209	0.068	6.485	8.469	0.748	0.156	0.625	0.058	2.690
365.7	40	23	6	0.068	2.991	18.805	18.923	0.202	0.068	6.655	8.795	0.744	0.150	0.605	0.057	2.632
363.2	42.5	14	4	0.064	3.156	11.143	11.143	0.123	0.064	6.820	9.116	0.740	0.091	0.584	0.056	1.625
360.7	45	19	4	0.067	3.320	14.745	14.745	0.158	0.067	6.984	9.436	0.737	0.116	0.564	0.054	2.148
358.2	47.5	13	4	0.063	3.483	9.850	9.850	0.112	0.063	7.147	9.755	0.733	0.082	0.544	0.053	1.547
355.7	50	20	12	0.067	3.646	14.811	16.832	0.179	0.067	7.310	10.074	0.730	0.131	0.524	0.052	2.519
353.2	52.5	24	6	0.069	3.816	17.372	17.483	0.186	0.069	7.480	10.400	0.727	0.135	0.503	0.050	2.700
350.7	55	25	6	0.069	3.989	17.699	17.812	0.190	0.069	7.653	10.729	0.723	0.137	0.483	0.048	2.854
348.2	57.5	31	6	0.071	4.164	20.780	20.907	0.227	0.071	7.828	11.060	0.720	0.163	0.463	0.047	3.468
345.7	60	32	6	0.071	4.342	20.884	21.012	0.228	0.071	8.006	11.394	0.717	0.163	0.443	0.045	3.622
343.2	62.5	54	6	0.076	4.526	34.306	34.497	1.000	0.076	8.190	11.734	0.714	0.714	0.422	0.043	N60cs>25
340.7	65	27	6	0.070	4.709	16.711	16.819	0.179	0.070	8.373	12.073	0.710	0.127	0.402	0.041	3.098
338.2	67.5	38	6	0.073	4.888	22.942	23.079	0.258	0.073	8.552	12.408	0.707	0.182	0.382	0.040	4.550
335.7	70	34	6	0.072	5.069	20.029	20.153	0.217	0.072	8.733	12.745	0.704	0.153	0.362	0.038	4.026
333.2	72.5	62	6	0.078	5.257	35.628	35.825	1.000	0.078	8.921	13.089	0.701	0.701	0.341	0.036	N60cs>25
330.7	75	20	6	0.067	5.438	11.227	11.309	0.125	0.067	9.102	13.426	0.699	0.087	0.321	0.034	2.559
328.2	77.5	41	6	0.074	5.614	22.511	22.646	0.252	0.074	9.278	13.758	0.696	0.175	0.301	0.032	5.469
325.7	80	16	12	0.065	5.788	8.598	10.423	0.117	0.065	9.452	14.088	0.693	0.081	0.281	0.030	2.700

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-05** **2500 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **35.99** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.270** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **6.0** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **30.29** FT. (Which is 3.6348 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.770</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
403.2	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	4.101	4.101	1.551	<b>0.240</b>	0.908	<b>0.159</b>	<b>ABO. WAT.</b>
400.7	5	4	50	0.109	0.578	5.403	11.484	0.126	0.109	4.379	4.379	1.531	<b>0.193</b>	0.888	<b>0.156</b>	<b>ABO. WAT.</b>
398.2	7.5	4	50	0.109	0.851	5.008	11.010	0.122	0.054	4.583	4.695	1.517	<b>0.185</b>	0.868	<b>0.156</b>	<b>NL</b>
395.7	10	3	50	0.052	1.052	3.470	9.164	0.106	0.052	4.716	4.984	1.508	<b>0.160</b>	0.848	<b>0.157</b>	<b>NL</b>
393.2	12.5	8	35	0.059	1.191	8.927	15.712	0.167	0.059	4.855	5.279	1.500	<b>0.251</b>	0.827	<b>0.158</b>	<b>1.589</b>
390.7	15	9	35	0.060	1.340	9.713	16.656	0.177	0.060	5.004	5.584	1.491	<b>0.264</b>	0.807	<b>0.158</b>	<b>1.671</b>
388.2	17.5	13	6	0.063	1.494	13.622	13.716	0.147	0.063	5.158	5.894	1.482	<b>0.218</b>	0.787	<b>0.158</b>	<b>1.380</b>
385.7	20	13	6	0.063	1.652	13.272	13.364	0.144	0.063	5.316	6.208	1.473	<b>0.212</b>	0.767	<b>0.157</b>	<b>1.350</b>
383.2	22.5	24	6	0.069	1.817	23.923	24.065	0.275	0.069	5.481	6.529	1.464	<b>0.403</b>	0.746	<b>0.156</b>	<b>2.583</b>
380.7	25	19	6	0.067	1.987	18.535	18.652	0.199	0.067	5.651	6.855	1.455	<b>0.290</b>	0.726	<b>0.155</b>	<b>1.871</b>
378.2	27.5	24	6	0.069	2.157	22.985	23.123	0.259	0.069	5.821	7.181	1.446	<b>0.375</b>	0.706	<b>0.153</b>	<b>2.451</b>
375.7	30	14	6	0.064	2.323	12.988	13.079	0.141	0.064	5.987	7.503	1.438	<b>0.203</b>	0.686	<b>0.151</b>	<b>1.344</b>
373.2	32.5	20	6	0.067	2.487	17.933	18.047	0.192	0.067	6.151	7.823	1.430	<b>0.275</b>	0.665	<b>0.148</b>	<b>1.858</b>
370.7	35	17	6	0.066	2.653	14.758	14.857	0.159	0.066	6.317	8.145	1.423	<b>0.226</b>	0.645	<b>0.146</b>	<b>1.548</b>
368.2	37.5	23	6	0.068	2.821	19.363	19.484	0.209	0.068	6.485	8.469	1.415	<b>0.296</b>	0.625	<b>0.143</b>	<b>2.070</b>
365.7	40	23	6	0.068	2.991	18.805	18.923	0.202	0.068	6.655	8.795	1.408	<b>0.284</b>	0.605	<b>0.140</b>	<b>2.029</b>
363.2	42.5	14	4	0.064	3.156	11.143	11.143	0.123	0.064	6.820	9.116	1.401	<b>0.172</b>	0.584	<b>0.137</b>	<b>1.255</b>
360.7	45	19	4	0.067	3.320	14.745	14.745	0.158	0.067	6.984	9.436	1.395	<b>0.220</b>	0.564	<b>0.134</b>	<b>1.642</b>
358.2	47.5	13	4	0.063	3.483	9.850	9.850	0.112	0.063	7.147	9.755	1.388	<b>0.155</b>	0.544	<b>0.130</b>	<b>1.192</b>
355.7	50	20	12	0.067	3.646	14.811	16.832	0.179	0.067	7.310	10.074	1.382	<b>0.247</b>	0.524	<b>0.127</b>	<b>1.945</b>
353.2	52.5	24	6	0.069	3.816	17.372	17.483	0.186	0.069	7.480	10.400	1.375	<b>0.256</b>	0.503	<b>0.123</b>	<b>2.081</b>
350.7	55	25	6	0.069	3.989	17.699	17.812	0.190	0.069	7.653	10.729	1.369	<b>0.260</b>	0.483	<b>0.119</b>	<b>2.185</b>
348.2	57.5	31	6	0.071	4.164	20.780	20.907	0.227	0.071	7.828	11.060	1.363	<b>0.309</b>	0.463	<b>0.115</b>	<b>2.687</b>
345.7	60	32	6	0.071	4.342	20.884	21.012	0.228	0.071	8.006	11.394	1.357	<b>0.309</b>	0.443	<b>0.111</b>	<b>2.784</b>
343.2	62.5	54	6	0.076	4.526	34.306	34.497	1.000	0.076	8.190	11.734	1.351	<b>1.351</b>	0.422	<b>0.106</b>	<b>N60cs&gt;25</b>
340.7	65	27	6	0.070	4.709	16.711	16.819	0.179	0.070	8.373	12.073	1.345	<b>0.241</b>	0.402	<b>0.102</b>	<b>2.363</b>
338.2	67.5	38	6	0.073	4.888	22.942	23.079	0.258	0.073	8.552	12.408	1.339	<b>0.345</b>	0.382	<b>0.097</b>	<b>3.557</b>
335.7	70	34	6	0.072	5.069	20.029	20.153	0.217	0.072	8.733	12.745	1.334	<b>0.289</b>	0.362	<b>0.093</b>	<b>3.108</b>
333.2	72.5	62	6	0.078	5.257	35.628	35.825	1.000	0.078	8.921	13.089	1.328	<b>1.328</b>	0.341	<b>0.088</b>	<b>N60cs&gt;25</b>
330.7	75	20	6	0.067	5.438	11.227	11.309	0.125	0.067	9.102	13.426	1.323	<b>0.165</b>	0.321	<b>0.083</b>	<b>1.988</b>
328.2	77.5	41	6	0.074	5.614	22.511	22.646	0.252	0.074	9.278	13.758	1.317	<b>0.332</b>	0.301	<b>0.078</b>	<b>4.256</b>
325.7	80	16	12	0.065	5.788	8.598	10.423	0.117	0.065	9.452	14.088	1.313	<b>0.154</b>	0.281	<b>0.074</b>	<b>2.081</b>

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-06** **1000 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.80** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **34.49** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.100** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.5** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **28.69** FT. (Which is 3.4428 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor	<b>(K<math>\alpha</math>)= 1.00</b>
Earthquake Magnitude Scaling Factor	<b>(MSF)= 1.000</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K $\sigma$ )(K $\alpha$ )(MSF)					
403.3	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	3.914	3.914	0.885	0.137	0.921	0.060	ABO. WAT.	
400.8	5	7	50	0.115	0.585	9.455	16.346	0.174	0.115	4.199	4.199	0.872	0.152	0.901	0.059	ABO. WAT.	
398.3	7.5	4	50	0.109	0.865	4.967	10.960	0.122	0.054	4.410	4.516	0.864	0.105	0.881	0.059	NL	
395.8	10	5	50	0.055	1.070	5.734	11.881	0.130	0.055	4.546	4.808	0.859	0.112	0.861	0.059	NL	
393.3	12.5	6	20	0.057	1.210	6.643	10.785	0.120	0.057	4.686	5.104	0.853	0.102	0.840	0.059	1.729	
390.8	15	7	20	0.058	1.354	7.515	11.727	0.129	0.058	4.830	5.404	0.848	0.109	0.820	0.060	1.817	
388.3	17.5	11	35	0.062	1.504	11.488	18.786	0.201	0.062	4.980	5.710	0.843	0.169	0.800	0.060	2.817	
385.8	20	15	12	0.065	1.663	15.263	17.298	0.184	0.065	5.139	6.025	0.838	0.154	0.780	0.059	2.610	
383.3	22.5	7	12	0.058	1.817	6.978	8.752	0.102	0.058	5.293	6.335	0.833	0.085	0.759	0.059	1.441	
380.8	25	18	5	0.066	1.972	17.626	17.626	0.188	0.066	5.448	6.646	0.828	0.156	0.739	0.059	2.644	
378.3	27.5	16	5	0.065	2.136	15.399	15.399	0.164	0.065	5.612	6.966	0.823	0.135	0.719	0.058	2.328	
375.8	30	29	5	0.071	2.306	27.003	27.003	0.338	0.071	5.782	27.003	0.818	0.276	0.699	0.057	N60cs>25	
373.3	32.5	33	5	0.072	2.485	29.601	29.601	0.442	0.072	5.961	7.627	0.813	0.359	0.678	0.056	N60cs>25	
370.8	35	20	5	0.067	2.659	17.343	17.343	0.185	0.067	6.135	7.957	0.809	0.150	0.658	0.055	2.727	
368.3	37.5	21	5	0.068	2.828	17.657	17.657	0.188	0.068	6.304	8.282	0.804	0.151	0.638	0.054	2.796	
365.8	40	11	5	0.062	2.991	8.994	8.994	0.104	0.062	6.467	8.601	0.800	0.083	0.618	0.053	1.566	
363.3	42.5	23	5	0.068	3.154	18.312	18.312	0.195	0.068	6.630	8.920	0.796	0.155	0.597	0.052	2.981	
360.8	45	17	5	0.066	3.322	13.189	13.189	0.142	0.066	6.798	9.244	0.792	0.112	0.577	0.051	2.196	
358.3	47.5	23	5	0.068	3.490	17.409	17.409	0.185	0.068	6.966	9.568	0.788	0.146	0.557	0.050	2.920	
355.8	50	20	5	0.067	3.659	14.784	14.784	0.158	0.067	7.135	9.893	0.784	0.124	0.537	0.048	2.583	
353.3	52.5	25	5	0.069	3.829	18.065	18.065	0.193	0.069	7.305	10.219	0.781	0.151	0.516	0.047	3.213	
350.8	55	39	5	0.073	4.007	26.783	26.783	0.332	0.073	7.483	10.553	0.777	0.258	0.496	0.045	N60cs>25	
348.3	57.5	26	5	0.070	4.186	17.370	17.370	0.185	0.070	7.662	10.888	0.773	0.143	0.476	0.044	3.250	
345.8	60	31	5	0.071	4.362	20.172	20.172	0.218	0.071	7.838	11.220	0.770	0.168	0.456	0.042	4.000	
343.3	62.5	38	5	0.073	4.542	24.085	24.085	0.275	0.073	8.018	11.556	0.766	0.211	0.435	0.041	5.146	
340.8	65	39	5	0.073	4.725	24.084	24.084	0.275	0.073	8.201	11.895	0.763	0.210	0.415	0.039	5.385	
338.3	67.5	33	5	0.072	4.906	19.874	19.874	0.214	0.072	8.382	12.232	0.760	0.163	0.395	0.037	4.405	
335.8	70	38	12	0.073	5.087	22.332	24.591	0.284	0.073	8.563	12.569	0.756	0.215	0.375	0.036	5.972	
333.3	72.5	52	5	0.076	5.273	29.819	29.819	0.455	0.076	8.749	12.911	0.753	0.343	0.354	0.034	N60cs>25	
330.8	75	43	5	0.074	5.461	24.068	24.068	0.275	0.074	8.937	13.255	0.750	0.206	0.334	0.032	6.438	
328.3	77.5	24	12	0.069	5.640	13.134	15.102	0.161	0.069	9.116	13.590	0.747	0.120	0.314	0.030	4.000	
325.8	80	16	12	0.065	5.808	8.577	10.401	0.117	0.065	9.284	13.914	0.744	0.087	0.294	0.029	3.000	

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-06** **1000 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.80** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **34.49** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.190** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **5.6** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **28.69** FT. (Which is 3.4428 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)=</b> 1.00
Earthquake Magnitude Scaling Factor <b>(MSF)=</b> 2.112

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
403.3	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	3.914	3.914	1.868	<b>0.290</b>	0.921	<b>0.114</b>	<b>ABO. WAT.</b>	
400.8	5	7	50	0.115	0.585	9.455	16.346	0.174	0.115	4.199	4.199	1.842	<b>0.321</b>	0.901	<b>0.111</b>	<b>ABO. WAT.</b>	
398.3	7.5	4	50	0.109	0.865	4.967	10.960	0.122	0.054	4.410	4.516	1.824	<b>0.223</b>	0.881	<b>0.111</b>	<b>NL</b>	
395.8	10	5	50	0.055	1.070	5.734	11.881	0.130	0.055	4.546	4.808	1.813	<b>0.236</b>	0.861	<b>0.112</b>	<b>NL</b>	
393.3	12.5	6	20	0.057	1.210	6.643	10.785	0.120	0.057	4.686	5.104	1.802	<b>0.216</b>	0.840	<b>0.113</b>	<b>1.912</b>	
390.8	15	7	20	0.058	1.354	7.515	11.727	0.129	0.058	4.830	5.404	1.791	<b>0.231</b>	0.820	<b>0.113</b>	<b>2.044</b>	
388.3	17.5	11	35	0.062	1.504	11.488	18.786	0.201	0.062	4.980	5.710	1.780	<b>0.358</b>	0.800	<b>0.113</b>	<b>3.168</b>	
385.8	20	15	12	0.065	1.663	15.263	17.298	0.184	0.065	5.139	6.025	1.769	<b>0.325</b>	0.780	<b>0.113</b>	<b>2.876</b>	
383.3	22.5	7	12	0.058	1.817	6.978	8.752	0.102	0.058	5.293	6.335	1.759	<b>0.179</b>	0.759	<b>0.112</b>	<b>1.598</b>	
380.8	25	18	5	0.066	1.972	17.626	17.626	0.188	0.066	5.448	6.646	1.749	<b>0.329</b>	0.739	<b>0.111</b>	<b>2.964</b>	
378.3	27.5	16	5	0.065	2.136	15.399	15.399	0.164	0.065	5.612	6.966	1.738	<b>0.285</b>	0.719	<b>0.110</b>	<b>2.591</b>	
375.8	30	29	5	0.071	2.306	27.003	27.003	0.338	0.071	5.782	7.292	1.728	<b>0.584</b>	0.699	<b>0.109</b>	<b>N60cs&gt;25</b>	
373.3	32.5	33	5	0.072	2.485	29.601	29.601	0.442	0.072	5.961	7.627	1.718	<b>0.759</b>	0.678	<b>0.107</b>	<b>N60cs&gt;25</b>	
370.8	35	20	5	0.067	2.659	17.343	17.343	0.185	0.067	6.135	7.957	1.708	<b>0.316</b>	0.658	<b>0.105</b>	<b>3.010</b>	
368.3	37.5	21	5	0.068	2.828	17.657	17.657	0.188	0.068	6.304	8.282	1.698	<b>0.319</b>	0.638	<b>0.104</b>	<b>3.067</b>	
365.8	40	11	5	0.062	2.991	8.994	8.994	0.104	0.062	6.467	8.601	1.690	<b>0.176</b>	0.618	<b>0.102</b>	<b>1.725</b>	
363.3	42.5	23	5	0.068	3.154	18.312	18.312	0.195	0.068	6.630	8.920	1.681	<b>0.328</b>	0.597	<b>0.099</b>	<b>3.313</b>	
360.8	45	17	5	0.066	3.322	13.189	13.189	0.142	0.066	6.798	9.244	1.673	<b>0.238</b>	0.577	<b>0.097</b>	<b>2.454</b>	
358.3	47.5	23	5	0.068	3.490	17.409	17.409	0.185	0.068	6.966	9.568	1.665	<b>0.308</b>	0.557	<b>0.094</b>	<b>3.277</b>	
355.8	50	20	5	0.067	3.659	14.784	14.784	0.158	0.067	7.135	9.893	1.657	<b>0.262</b>	0.537	<b>0.092</b>	<b>2.848</b>	
353.3	52.5	25	5	0.069	3.829	18.065	18.065	0.193	0.069	7.305	10.219	1.649	<b>0.318</b>	0.516	<b>0.089</b>	<b>3.573</b>	
350.8	55	39	5	0.073	4.007	26.783	26.783	0.332	0.073	7.483	10.553	1.641	<b>0.545</b>	0.496	<b>0.086</b>	<b>N60cs&gt;25</b>	
348.3	57.5	26	5	0.070	4.186	17.370	17.370	0.185	0.070	7.662	10.888	1.633	<b>0.302</b>	0.476	<b>0.084</b>	<b>3.595</b>	
345.8	60	31	5	0.071	4.362	20.172	20.172	0.218	0.071	7.838	11.220	1.626	<b>0.354</b>	0.456	<b>0.081</b>	<b>4.370</b>	
343.3	62.5	38	5	0.073	4.542	24.085	24.085	0.275	0.073	8.018	11.556	1.619	<b>0.445</b>	0.435	<b>0.077</b>	<b>5.779</b>	
340.8	65	39	5	0.073	4.725	24.084	24.084	0.275	0.073	8.201	11.895	1.611	<b>0.443</b>	0.415	<b>0.074</b>	<b>5.986</b>	
338.3	67.5	33	5	0.072	4.906	19.874	19.874	0.214	0.072	8.382	12.232	1.604	<b>0.343</b>	0.395	<b>0.071</b>	<b>4.831</b>	
335.8	70	38	12	0.073	5.087	22.332	24.591	0.284	0.073	8.563	12.569	1.597	<b>0.454</b>	0.375	<b>0.068</b>	<b>6.676</b>	
333.3	72.5	52	5	0.076	5.273	29.819	29.819	0.455	0.076	8.749	12.911	1.591	<b>0.724</b>	0.354	<b>0.065</b>	<b>N60cs&gt;25</b>	
330.8	75	43	5	0.074	5.461	24.068	24.068	0.275	0.074	8.937	13.255	1.584	<b>0.436</b>	0.334	<b>0.061</b>	<b>7.148</b>	
328.3	77.5	24	12	0.069	5.640	13.134	15.102	0.161	0.069	9.116	13.590	1.578	<b>0.254</b>	0.314	<b>0.058</b>	<b>4.379</b>	
325.8	80	16	12	0.065	5.808	8.577	10.401	0.117	0.065	9.284	13.914	1.572	<b>0.184</b>	0.294	<b>0.054</b>	<b>3.407</b>	

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-06** **2500 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.80** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **34.49** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.120** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.7** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **28.69** FT. (Which is 3.4428 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor	<b>(K<math>\alpha</math>)= 1.00</b>
Earthquake Magnitude Scaling Factor	<b>(MSF)= 0.935</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)		Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)				
403.3	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	3.914	3.914	0.827	0.128	0.921	0.072	ABO. WAT.
400.8	5	7	50	0.115	0.585	9.455	16.346	0.174	0.115	4.199	4.199	0.816	0.142	0.901	0.070	ABO. WAT.
398.3	7.5	4	50	0.109	0.865	4.967	10.960	0.122	0.054	4.410	4.516	0.808	0.099	0.881	0.070	NL
395.8	10	5	50	0.055	1.070	5.734	11.881	0.130	0.055	4.546	4.808	0.803	0.104	0.861	0.071	NL
393.3	12.5	6	20	0.057	1.210	6.643	10.785	0.120	0.057	4.686	5.104	0.798	0.096	0.840	0.071	1.352
390.8	15	7	20	0.058	1.354	7.515	11.727	0.129	0.058	4.830	5.404	0.793	0.102	0.820	0.072	1.417
388.3	17.5	11	35	0.062	1.504	11.488	18.786	0.201	0.062	4.980	5.710	0.788	0.158	0.800	0.072	2.194
385.8	20	15	12	0.065	1.663	15.263	17.298	0.184	0.065	5.139	6.025	0.783	0.144	0.780	0.071	2.028
383.3	22.5	7	12	0.058	1.817	6.978	8.752	0.102	0.058	5.293	6.335	0.779	0.079	0.759	0.071	1.113
380.8	25	18	5	0.066	1.972	17.626	17.626	0.188	0.066	5.448	6.646	0.774	0.146	0.739	0.070	2.086
378.3	27.5	16	5	0.065	2.136	15.399	15.399	0.164	0.065	5.612	6.966	0.770	0.126	0.719	0.070	1.800
375.8	30	29	5	0.071	2.306	27.003	27.003	0.338	0.071	5.782	7.292	0.765	0.259	0.699	0.069	N60cs>25
373.3	32.5	33	5	0.072	2.485	29.601	29.601	0.442	0.072	5.961	7.627	0.760	0.336	0.678	0.068	N60cs>25
370.8	35	20	5	0.067	2.659	17.343	17.343	0.185	0.067	6.135	7.957	0.756	0.140	0.658	0.067	2.090
368.3	37.5	21	5	0.068	2.828	17.657	17.657	0.188	0.068	6.304	8.282	0.752	0.141	0.638	0.065	2.169
365.8	40	11	5	0.062	2.991	8.994	8.994	0.104	0.062	6.467	8.601	0.748	0.078	0.618	0.064	1.219
363.3	42.5	23	5	0.068	3.154	18.312	18.312	0.195	0.068	6.630	8.920	0.744	0.145	0.597	0.063	2.302
360.8	45	17	5	0.066	3.322	13.189	13.189	0.142	0.066	6.798	9.244	0.741	0.105	0.577	0.061	1.721
358.3	47.5	23	5	0.068	3.490	17.409	17.409	0.185	0.068	6.966	9.568	0.737	0.136	0.557	0.060	2.267
355.8	50	20	5	0.067	3.659	14.784	14.784	0.158	0.067	7.135	9.893	0.733	0.116	0.537	0.058	2.000
353.3	52.5	25	5	0.069	3.829	18.065	18.065	0.193	0.069	7.305	10.219	0.730	0.141	0.516	0.056	2.518
350.8	55	39	5	0.073	4.007	26.783	26.783	0.332	0.073	7.483	10.553	0.727	0.241	0.496	0.055	N60cs>25
348.3	57.5	26	5	0.070	4.186	17.370	17.370	0.185	0.070	7.662	10.888	0.723	0.134	0.476	0.053	2.528
345.8	60	31	5	0.071	4.362	20.172	20.172	0.218	0.071	7.838	11.220	0.720	0.157	0.456	0.051	3.078
343.3	62.5	38	5	0.073	4.542	24.085	24.085	0.275	0.073	8.018	11.556	0.717	0.197	0.435	0.049	4.020
340.8	65	39	5	0.073	4.725	24.084	24.084	0.275	0.073	8.201	11.895	0.713	0.196	0.415	0.047	4.170
338.3	67.5	33	5	0.072	4.906	19.874	19.874	0.214	0.072	8.382	12.232	0.710	0.152	0.395	0.045	3.378
335.8	70	38	12	0.073	5.087	22.332	24.591	0.284	0.073	8.563	12.569	0.707	0.201	0.375	0.043	4.674
333.3	72.5	52	5	0.076	5.273	29.819	29.819	0.455	0.076	8.749	12.911	0.704	0.320	0.354	0.041	N60cs>25
330.8	75	43	5	0.074	5.461	24.068	24.068	0.275	0.074	8.937	13.255	0.701	0.193	0.334	0.039	4.949
328.3	77.5	24	12	0.069	5.640	13.134	15.102	0.161	0.069	9.116	13.590	0.698	0.112	0.314	0.037	3.027
325.8	80	16	12	0.065	5.808	8.577	10.401	0.117	0.065	9.284	13.914	0.696	0.081	0.294	0.034	2.382

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-06** **2500 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.80** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **34.49** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.260** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **6.0** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **28.69** FT. (Which is 3.4428 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<math>\alpha</math>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.770</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K $\sigma$ )(K $\alpha$ )(MSF)					
403.3	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	3.914	3.914	1.566	<b>0.243</b>	0.921	<b>0.156</b>	<b>ABO. WAT.</b>	
400.8	5	7	50	0.115	0.585	9.455	16.346	0.174	0.115	4.199	4.199	1.544	<b>0.269</b>	0.901	<b>0.152</b>	<b>ABO. WAT.</b>	
398.3	7.5	4	50	0.109	0.865	4.967	10.960	0.122	0.054	4.410	4.516	1.529	<b>0.187</b>	0.881	<b>0.152</b>	NL	
395.8	10	5	50	0.055	1.070	5.734	11.881	0.130	0.055	4.546	4.808	1.520	<b>0.198</b>	0.861	<b>0.154</b>	NL	
393.3	12.5	6	20	0.057	1.210	6.643	10.785	0.120	0.057	4.686	5.104	1.510	<b>0.181</b>	0.840	<b>0.155</b>	1.168	
390.8	15	7	20	0.058	1.354	7.515	11.727	0.129	0.058	4.830	5.404	1.501	<b>0.194</b>	0.820	<b>0.155</b>	1.252	
388.3	17.5	11	35	0.062	1.504	11.488	18.786	0.201	0.062	4.980	5.710	1.492	<b>0.300</b>	0.800	<b>0.155</b>	1.935	
385.8	20	15	12	0.065	1.663	15.263	17.298	0.184	0.065	5.139	6.025	1.483	<b>0.273</b>	0.780	<b>0.155</b>	1.761	
383.3	22.5	7	12	0.058	1.817	6.978	8.752	0.102	0.058	5.293	6.335	1.474	<b>0.150</b>	0.759	<b>0.154</b>	<b>0.974</b>	
380.8	25	18	5	0.066	1.972	17.626	17.626	0.188	0.066	5.448	6.646	1.466	<b>0.276</b>	0.739	<b>0.152</b>	1.816	
378.3	27.5	16	5	0.065	2.136	15.399	15.399	0.164	0.065	5.612	6.966	1.457	<b>0.239</b>	0.719	<b>0.151</b>	1.583	
375.8	30	29	5	0.071	2.306	27.003	27.003	0.338	0.071	5.782	7.292	1.448	<b>0.489</b>	0.699	<b>0.149</b>	<b>N60cs&gt;25</b>	
373.3	32.5	33	5	0.072	2.485	29.601	29.601	0.442	0.072	5.961	7.627	1.439	<b>0.636</b>	0.678	<b>0.147</b>	<b>N60cs&gt;25</b>	
370.8	35	20	5	0.067	2.659	17.343	17.343	0.185	0.067	6.135	7.957	1.431	<b>0.265</b>	0.658	<b>0.144</b>	1.840	
368.3	37.5	21	5	0.068	2.828	17.657	17.657	0.188	0.068	6.304	8.282	1.423	<b>0.268</b>	0.638	<b>0.142</b>	1.887	
365.8	40	11	5	0.062	2.991	8.994	8.994	0.104	0.062	6.467	8.601	1.416	<b>0.147</b>	0.618	<b>0.139</b>	1.058	
363.3	42.5	23	5	0.068	3.154	18.312	18.312	0.195	0.068	6.630	8.920	1.409	<b>0.275</b>	0.597	<b>0.136</b>	2.022	
360.8	45	17	5	0.066	3.322	13.189	13.189	0.142	0.066	6.798	9.244	1.402	<b>0.199</b>	0.577	<b>0.133</b>	1.496	
358.3	47.5	23	5	0.068	3.490	17.409	17.409	0.185	0.068	6.966	9.568	1.395	<b>0.258</b>	0.557	<b>0.129</b>	2.000	
355.8	50	20	5	0.067	3.659	14.784	14.784	0.158	0.067	7.135	9.893	1.389	<b>0.219</b>	0.537	<b>0.126</b>	1.738	
353.3	52.5	25	5	0.069	3.829	18.065	18.065	0.193	0.069	7.305	10.219	1.382	<b>0.267</b>	0.516	<b>0.122</b>	2.189	
350.8	55	39	5	0.073	4.007	26.783	26.783	0.332	0.073	7.483	10.553	1.375	<b>0.457</b>	0.496	<b>0.118</b>	<b>N60cs&gt;25</b>	
348.3	57.5	26	5	0.070	4.186	17.370	17.370	0.185	0.070	7.662	10.888	1.369	<b>0.253</b>	0.476	<b>0.114</b>	2.219	
345.8	60	31	5	0.071	4.362	20.172	20.172	0.218	0.071	7.838	11.220	1.363	<b>0.297</b>	0.456	<b>0.110</b>	2.700	
343.3	62.5	38	5	0.073	4.542	24.085	24.085	0.275	0.073	8.018	11.556	1.357	<b>0.373</b>	0.435	<b>0.106</b>	3.519	
340.8	65	39	5	0.073	4.725	24.084	24.084	0.275	0.073	8.201	11.895	1.350	<b>0.371</b>	0.415	<b>0.102</b>	3.637	
338.3	67.5	33	5	0.072	4.906	19.874	19.874	0.214	0.072	8.382	12.232	1.345	<b>0.288</b>	0.395	<b>0.097</b>	2.969	
335.8	70	38	12	0.073	5.087	22.332	24.591	0.284	0.073	8.563	12.569	1.339	<b>0.380</b>	0.375	<b>0.093</b>	4.086	
333.3	72.5	52	5	0.076	5.273	29.819	29.819	0.455	0.076	8.749	12.911	1.333	<b>0.607</b>	0.354	<b>0.088</b>	<b>N60cs&gt;25</b>	
330.8	75	43	5	0.074	5.461	24.068	24.068	0.275	0.074	8.937	13.255	1.327	<b>0.365</b>	0.334	<b>0.084</b>	4.345	
328.3	77.5	24	12	0.069	5.640	13.134	15.102	0.161	0.069	9.116	13.590	1.322	<b>0.213</b>	0.314	<b>0.079</b>	2.696	
325.8	80	16	12	0.065	5.808	8.577	10.401	0.117	0.065	9.284	13.914	1.317	<b>0.154</b>	0.294	<b>0.074</b>	2.081	

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-07** **1000 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **32.99** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.100** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.5** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **27.29** FT. (Which is 3.2748 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.000</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)		Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> )60	Fines Content Corrected (N <sub>1</sub> )60cs	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)				
403.2	2.5	9	50	0.117	0.300	11.815	19.178	0.205	0.117	3.741	3.741	0.893	0.183	0.931	0.061	ABO. WAT.
400.7	5	5	50	0.111	0.585	6.753	13.104	0.142	0.111	4.026	4.026	0.880	0.125	0.912	0.059	ABO. WAT.
398.2	7.5	10	35	0.118	0.871	12.375	19.850	0.214	0.061	4.241	4.353	0.871	0.186	0.892	0.060	3.100
395.7	10	2	35	0.049	1.080	2.283	7.740	0.094	0.049	4.379	4.647	0.865	0.081	0.872	0.060	1.350
393.2	12.5	14	50	0.064	1.221	15.429	23.515	0.265	0.064	4.520	4.944	0.859	0.228	0.852	0.061	NL
390.7	15	8	12	0.059	1.375	8.523	10.346	0.116	0.059	4.674	5.254	0.854	0.099	0.831	0.061	1.623
388.2	17.5	11	6	0.062	1.526	11.404	11.487	0.126	0.062	4.825	5.561	0.848	0.107	0.811	0.061	1.754
385.7	20	16	50	0.065	1.685	16.174	24.409	0.281	0.065	4.984	5.876	0.843	0.237	0.791	0.061	NL
383.2	22.5	8	6	0.059	1.840	7.924	7.991	0.096	0.059	5.139	6.187	0.838	0.080	0.771	0.060	1.333
380.7	25	18	6	0.066	1.996	17.520	17.632	0.188	0.066	5.295	6.499	0.833	0.157	0.750	0.060	2.617
378.2	27.5	9	6	0.060	2.154	8.625	8.695	0.102	0.060	5.453	6.813	0.828	0.084	0.730	0.059	1.424
375.7	30	8	6	0.059	2.303	7.454	7.519	0.092	0.059	5.602	7.118	0.823	0.076	0.710	0.059	1.288
373.2	32.5	24	6	0.069	2.463	21.624	21.755	0.239	0.069	5.762	7.434	0.819	0.196	0.690	0.058	3.379
370.7	35	34	6	0.072	2.639	29.594	29.763	0.452	0.072	5.938	7.766	0.814	0.368	0.669	0.057	N60cs>25
368.2	37.5	23	6	0.068	2.814	19.387	19.508	0.209	0.068	6.113	8.097	0.809	0.169	0.649	0.056	3.018
365.7	40	25	6	0.069	2.985	20.461	20.587	0.223	0.069	6.284	8.424	0.805	0.180	0.629	0.055	3.273
363.2	42.5	26	6	0.070	3.159	20.685	20.812	0.226	0.070	6.458	8.754	0.800	0.181	0.609	0.054	3.352
360.7	45	27	6	0.070	3.334	20.909	21.037	0.229	0.070	6.633	9.085	0.796	0.182	0.588	0.052	3.500
358.2	47.5	31	6	0.071	3.510	23.397	23.537	0.266	0.071	6.809	9.417	0.792	0.211	0.568	0.051	4.137
355.7	50	25	6	0.069	3.685	18.415	18.531	0.198	0.069	6.984	9.748	0.788	0.156	0.548	0.050	3.120
353.2	52.5	20	6	0.067	3.855	14.403	14.500	0.155	0.067	7.154	10.074	0.784	0.122	0.528	0.048	2.542
350.7	55	23	6	0.068	4.024	15.753	15.857	0.169	0.068	7.323	10.399	0.780	0.132	0.507	0.047	2.809
348.2	57.5	4	6	0.054	4.177	2.676	2.718	0.050	0.054	7.476	10.708	0.777	0.039	0.487	0.045	0.867
345.7	60	7	12	0.058	4.317	4.585	6.283	0.082	0.058	7.616	11.004	0.774	0.063	0.467	0.044	1.432
343.2	62.5	23	6	0.068	4.475	14.720	14.819	0.158	0.068	7.774	11.318	0.771	0.122	0.447	0.042	2.905
340.7	65	31	6	0.071	4.649	19.350	19.471	0.209	0.071	7.948	11.648	0.768	0.161	0.426	0.041	3.927
338.2	67.5	49	6	0.076	4.833	29.808	29.978	0.466	0.076	8.132	11.988	0.764	0.356	0.406	0.039	N60cs>25
335.7	70	42	6	0.074	5.021	24.902	25.049	0.293	0.074	8.320	12.332	0.761	0.223	0.386	0.037	N60cs>25
333.2	72.5	73	6	0.079	5.212	42.197	42.425	1.000	0.079	8.511	12.679	0.757	0.757	0.366	0.035	N60cs>25
330.7	75	33	6	0.072	5.401	18.613	18.730	0.200	0.072	8.700	13.024	0.754	0.151	0.345	0.034	4.441
328.2	77.5	26	12	0.070	5.579	14.338	16.344	0.174	0.070	8.878	13.358	0.751	0.131	0.325	0.032	4.094
325.7	80	15	12	0.065	5.748	8.100	9.909	0.112	0.065	9.047	13.683	0.748	0.084	0.305	0.030	2.800

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction



# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-07** **1000 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **32.99** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.190** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **5.6** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **27.29** FT. (Which is 3.2748 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<math>\alpha</math>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 2.112</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K $\sigma$ )(K $\alpha$ )(MSF)				
403.2	2.5	9	50	0.117	0.300	11.815	19.178	0.205	0.117	3.741	3.741	1.885	0.386	0.931	0.115	ABO. WAT.
400.7	5	5	50	0.111	0.585	6.753	13.104	0.142	0.111	4.026	4.026	1.858	0.264	0.912	0.113	ABO. WAT.
398.2	7.5	10	35	0.118	0.871	12.375	19.850	0.214	0.061	4.241	4.353	1.839	0.394	0.892	0.113	3.487
395.7	10	2	35	0.049	1.080	2.283	7.740	0.094	0.049	4.379	4.647	1.827	0.172	0.872	0.114	1.509
393.2	12.5	14	50	0.064	1.221	15.429	23.515	0.265	0.064	4.520	4.944	1.815	0.481	0.852	0.115	NL
390.7	15	8	12	0.059	1.375	8.523	10.346	0.116	0.059	4.674	5.254	1.803	0.209	0.831	0.115	1.817
388.2	17.5	11	6	0.062	1.526	11.404	11.487	0.126	0.062	4.825	5.561	1.792	0.226	0.811	0.115	1.965
385.7	20	16	50	0.065	1.685	16.174	24.409	0.281	0.065	4.984	5.876	1.780	0.500	0.791	0.115	NL
383.2	22.5	8	6	0.059	1.840	7.924	7.991	0.096	0.059	5.139	6.187	1.769	0.170	0.771	0.115	1.478
380.7	25	18	6	0.066	1.996	17.520	17.632	0.188	0.066	5.295	6.499	1.759	0.331	0.750	0.114	2.904
378.2	27.5	9	6	0.060	2.154	8.625	8.695	0.102	0.060	5.453	6.813	1.748	0.178	0.730	0.113	1.575
375.7	30	8	6	0.059	2.303	7.454	7.519	0.092	0.059	5.602	7.118	1.739	0.160	0.710	0.111	1.441
373.2	32.5	24	6	0.069	2.463	21.624	21.755	0.239	0.069	5.762	7.434	1.729	0.413	0.690	0.110	3.755
370.7	35	34	6	0.072	2.639	29.594	29.763	0.452	0.072	5.938	7.766	1.719	0.777	0.669	0.108	N60cs>25
368.2	37.5	23	6	0.068	2.814	19.387	19.508	0.209	0.068	6.113	8.097	1.709	0.357	0.649	0.106	3.368
365.7	40	25	6	0.069	2.985	20.461	20.587	0.223	0.069	6.284	8.424	1.699	0.379	0.629	0.104	3.644
363.2	42.5	26	6	0.070	3.159	20.685	20.812	0.226	0.070	6.458	8.754	1.690	0.382	0.609	0.102	3.745
360.7	45	27	6	0.070	3.334	20.909	21.037	0.229	0.070	6.633	9.085	1.681	0.385	0.588	0.099	3.889
358.2	47.5	31	6	0.071	3.510	23.397	23.537	0.266	0.071	6.809	9.417	1.672	0.445	0.568	0.097	4.588
355.7	50	25	6	0.069	3.685	18.415	18.531	0.198	0.069	6.984	9.748	1.664	0.329	0.548	0.094	3.500
353.2	52.5	20	6	0.067	3.855	14.403	14.500	0.155	0.067	7.154	10.074	1.656	0.257	0.528	0.092	2.793
350.7	55	23	6	0.068	4.024	15.753	15.857	0.169	0.068	7.323	10.399	1.648	0.279	0.507	0.089	3.135
348.2	57.5	4	6	0.054	4.177	2.676	2.718	0.050	0.054	7.476	10.708	1.641	0.082	0.487	0.086	0.953
345.7	60	7	12	0.058	4.317	4.585	6.283	0.082	0.058	7.616	11.004	1.635	0.134	0.467	0.083	1.614
343.2	62.5	23	6	0.068	4.475	14.720	14.819	0.158	0.068	7.774	11.318	1.629	0.257	0.447	0.080	3.213
340.7	65	31	6	0.071	4.649	19.350	19.471	0.209	0.071	7.948	11.648	1.621	0.339	0.426	0.077	4.403
338.2	67.5	49	6	0.076	4.833	29.808	29.978	0.466	0.076	8.132	11.988	1.614	0.752	0.406	0.074	N60cs>25
335.7	70	42	6	0.074	5.021	24.902	25.049	0.293	0.074	8.320	12.332	1.607	0.471	0.386	0.071	N60cs>25
333.2	72.5	73	6	0.079	5.212	42.197	42.425	1.000	0.079	8.511	12.679	1.599	1.599	0.366	0.067	N60cs>25
330.7	75	33	6	0.072	5.401	18.613	18.730	0.200	0.072	8.700	13.024	1.592	0.318	0.345	0.064	4.969
328.2	77.5	26	12	0.070	5.579	14.338	16.344	0.174	0.070	8.878	13.358	1.586	0.276	0.325	0.060	4.600
325.7	80	15	12	0.065	5.748	8.100	9.909	0.112	0.065	9.047	13.683	1.580	0.177	0.305	0.057	3.105

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-07** **2500 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **32.99** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.120** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.7** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **27.29** FT. (Which is 3.2748 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor	<b>(K<math>\alpha</math>)= 1.00</b>
Earthquake Magnitude Scaling Factor	<b>(MSF)= 0.935</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K $\sigma$ )(K $\alpha$ )(MSF)				
403.2	2.5	9	50	0.117	0.300	11.815	19.178	0.205	0.117	3.741	3.741	0.835	0.171	0.931	0.073	ABO. WAT.
400.7	5	5	50	0.111	0.585	6.753	13.104	0.142	0.111	4.026	4.026	0.822	0.117	0.912	0.071	ABO. WAT.
398.2	7.5	10	35	0.118	0.871	12.375	19.850	0.214	0.061	4.241	4.353	0.814	0.174	0.892	0.071	2.451
395.7	10	2	35	0.049	1.080	2.283	7.740	0.094	0.049	4.379	4.647	0.809	0.076	0.872	0.072	1.056
393.2	12.5	14	50	0.064	1.221	15.429	23.515	0.265	0.064	4.520	4.944	0.804	0.213	0.852	0.073	NL
390.7	15	8	12	0.059	1.375	8.523	10.346	0.116	0.059	4.674	5.254	0.798	0.093	0.831	0.073	1.274
388.2	17.5	11	6	0.062	1.526	11.404	11.487	0.126	0.062	4.825	5.561	0.793	0.100	0.811	0.073	1.370
385.7	20	16	50	0.065	1.685	16.174	24.409	0.281	0.065	4.984	5.876	0.788	0.221	0.791	0.073	NL
383.2	22.5	8	6	0.059	1.840	7.924	7.991	0.096	0.059	5.139	6.187	0.783	0.075	0.771	0.072	1.042
380.7	25	18	6	0.066	1.996	17.520	17.632	0.188	0.066	5.295	6.499	0.779	0.146	0.750	0.072	2.028
378.2	27.5	9	6	0.060	2.154	8.625	8.695	0.102	0.060	5.453	6.813	0.774	0.079	0.730	0.071	1.113
375.7	30	8	6	0.059	2.303	7.454	7.519	0.092	0.059	5.602	7.118	0.770	0.071	0.710	0.070	1.014
373.2	32.5	24	6	0.069	2.463	21.624	21.755	0.239	0.069	5.762	7.434	0.766	0.183	0.690	0.069	2.652
370.7	35	34	6	0.072	2.639	29.594	29.763	0.452	0.072	5.938	7.766	0.761	0.344	0.669	0.068	N60cs>25
368.2	37.5	23	6	0.068	2.814	19.387	19.508	0.209	0.068	6.113	8.097	0.757	0.158	0.649	0.067	2.358
365.7	40	25	6	0.069	2.985	20.461	20.587	0.223	0.069	6.284	8.424	0.752	0.168	0.629	0.066	2.545
363.2	42.5	26	6	0.070	3.159	20.685	20.812	0.226	0.070	6.458	8.754	0.748	0.169	0.609	0.064	2.641
360.7	45	27	6	0.070	3.334	20.909	21.037	0.229	0.070	6.633	9.085	0.744	0.170	0.588	0.063	2.698
358.2	47.5	31	6	0.071	3.510	23.397	23.537	0.266	0.071	6.809	9.417	0.740	0.197	0.568	0.061	3.230
355.7	50	25	6	0.069	3.685	18.415	18.531	0.198	0.069	6.984	9.748	0.737	0.146	0.548	0.060	2.433
353.2	52.5	20	6	0.067	3.855	14.403	14.500	0.155	0.067	7.154	10.074	0.733	0.114	0.528	0.058	1.966
350.7	55	23	6	0.068	4.024	15.753	15.857	0.169	0.068	7.323	10.399	0.730	0.123	0.507	0.056	2.196
348.2	57.5	4	6	0.054	4.177	2.676	2.718	0.050	0.054	7.476	10.708	0.727	0.036	0.487	0.054	0.667
345.7	60	7	12	0.058	4.317	4.585	6.283	0.082	0.058	7.616	11.004	0.724	0.059	0.467	0.053	1.113
343.2	62.5	23	6	0.068	4.475	14.720	14.819	0.158	0.068	7.774	11.318	0.721	0.114	0.447	0.051	2.235
340.7	65	31	6	0.071	4.649	19.350	19.471	0.209	0.071	7.948	11.648	0.718	0.150	0.426	0.049	3.061
338.2	67.5	49	6	0.076	4.833	29.808	29.978	0.466	0.076	8.132	11.988	0.715	0.333	0.406	0.047	N60cs>25
335.7	70	42	6	0.074	5.021	24.902	25.049	0.293	0.074	8.320	12.332	0.711	0.208	0.386	0.045	N60cs>25
333.2	72.5	73	6	0.079	5.212	42.197	42.425	1.000	0.079	8.511	12.679	0.708	0.708	0.366	0.043	N60cs>25
330.7	75	33	6	0.072	5.401	18.613	18.730	0.200	0.072	8.700	13.024	0.705	0.141	0.345	0.040	3.525
328.2	77.5	26	12	0.070	5.579	14.338	16.344	0.174	0.070	8.878	13.358	0.702	0.122	0.325	0.038	3.211
325.7	80	15	12	0.065	5.748	8.100	9.909	0.112	0.065	9.047	13.683	0.699	0.078	0.305	0.036	2.167

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-07** **2500 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **32.99** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.260** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **6.0** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **27.29** FT. (Which is 3.2748 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<math>\alpha</math>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.770</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K $\sigma$ )(K $\alpha$ )(MSF)				
403.2	2.5	9	50	0.117	0.300	11.815	19.178	0.205	0.117	3.741	3.741	1.580	0.324	0.931	0.157	ABO. WAT.
400.7	5	5	50	0.111	0.585	6.753	13.104	0.142	0.111	4.026	4.026	1.557	0.221	0.912	0.154	ABO. WAT.
398.2	7.5	10	35	0.118	0.871	12.375	19.850	0.214	0.061	4.241	4.353	1.541	0.330	0.892	0.155	2.129
395.7	10	2	35	0.049	1.080	2.283	7.740	0.094	0.049	4.379	4.647	1.531	0.144	0.872	0.156	0.923
393.2	12.5	14	50	0.064	1.221	15.429	23.515	0.265	0.064	4.520	4.944	1.521	0.403	0.852	0.157	NL
390.7	15	8	12	0.059	1.375	8.523	10.346	0.116	0.059	4.674	5.254	1.511	0.175	0.831	0.158	1.108
388.2	17.5	11	6	0.062	1.526	11.404	11.487	0.126	0.062	4.825	5.561	1.502	0.189	0.811	0.158	1.196
385.7	20	16	50	0.065	1.685	16.174	24.409	0.281	0.065	4.984	5.876	1.492	0.419	0.791	0.158	NL
383.2	22.5	8	6	0.059	1.840	7.924	7.991	0.096	0.059	5.139	6.187	1.483	0.142	0.771	0.157	0.904
380.7	25	18	6	0.066	1.996	17.520	17.632	0.188	0.066	5.295	6.499	1.474	0.277	0.750	0.156	1.776
378.2	27.5	9	6	0.060	2.154	8.625	8.695	0.102	0.060	5.453	6.813	1.465	0.149	0.730	0.154	0.968
375.7	30	8	6	0.059	2.303	7.454	7.519	0.092	0.059	5.602	7.118	1.457	0.134	0.710	0.152	0.882
373.2	32.5	24	6	0.069	2.463	21.624	21.755	0.239	0.069	5.762	7.434	1.449	0.346	0.690	0.150	2.307
370.7	35	34	6	0.072	2.639	29.594	29.763	0.452	0.072	5.938	7.766	1.440	0.651	0.669	0.148	N60cs>25
368.2	37.5	23	6	0.068	2.814	19.387	19.508	0.209	0.068	6.113	8.097	1.432	0.299	0.649	0.145	2.062
365.7	40	25	6	0.069	2.985	20.461	20.587	0.223	0.069	6.284	8.424	1.424	0.318	0.629	0.143	2.224
363.2	42.5	26	6	0.070	3.159	20.685	20.812	0.226	0.070	6.458	8.754	1.417	0.320	0.609	0.140	2.286
360.7	45	27	6	0.070	3.334	20.909	21.037	0.229	0.070	6.633	9.085	1.409	0.323	0.588	0.136	2.375
358.2	47.5	31	6	0.071	3.510	23.397	23.537	0.266	0.071	6.809	9.417	1.402	0.373	0.568	0.133	2.805
355.7	50	25	6	0.069	3.685	18.415	18.531	0.198	0.069	6.984	9.748	1.395	0.276	0.548	0.129	2.140
353.2	52.5	20	6	0.067	3.855	14.403	14.500	0.155	0.067	7.154	10.074	1.388	0.215	0.528	0.126	1.706
350.7	55	23	6	0.068	4.024	15.753	15.857	0.169	0.068	7.323	10.399	1.381	0.233	0.507	0.122	1.910
348.2	57.5	4	6	0.054	4.177	2.676	2.718	0.050	0.054	7.476	10.708	1.376	0.069	0.487	0.118	0.585
345.7	60	7	12	0.058	4.317	4.585	6.283	0.082	0.058	7.616	11.004	1.371	0.112	0.467	0.114	0.982
343.2	62.5	23	6	0.068	4.475	14.720	14.819	0.158	0.068	7.774	11.318	1.365	0.216	0.447	0.110	1.964
340.7	65	31	6	0.071	4.649	19.350	19.471	0.209	0.071	7.948	11.648	1.359	0.284	0.426	0.106	2.679
338.2	67.5	49	6	0.076	4.833	29.808	29.978	0.466	0.076	8.132	11.988	1.353	0.630	0.406	0.101	N60cs>25
335.7	70	42	6	0.074	5.021	24.902	25.049	0.293	0.074	8.320	12.332	1.347	0.395	0.386	0.097	N60cs>25
333.2	72.5	73	6	0.079	5.212	42.197	42.425	1.000	0.079	8.511	12.679	1.340	1.340	0.366	0.092	N60cs>25
330.7	75	33	6	0.072	5.401	18.613	18.730	0.200	0.072	8.700	13.024	1.335	0.267	0.345	0.087	3.069
328.2	77.5	26	12	0.070	5.579	14.338	16.344	0.174	0.070	8.878	13.358	1.329	0.231	0.325	0.083	2.783
325.7	80	15	12	0.065	5.748	8.100	9.909	0.112	0.065	9.047	13.683	1.324	0.148	0.305	0.078	1.897

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-08** **1000 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.30** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **31.49** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.100** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.5** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **26.19** FT. (Which is 3.1428 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.000</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
402.8	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	3.588	3.588	0.900	0.125	0.934	0.061	ABO. WAT.
400.3	5	5	50	0.111	0.578	6.753	13.104	0.142	0.111	3.866	3.866	0.887	0.126	0.921	0.060	ABO. WAT.
397.8	7.5	5	50	0.111	0.856	6.241	12.489	0.136	0.055	4.074	4.211	0.878	0.119	0.901	0.061	NL
395.3	10	7	6	0.058	1.067	8.039	8.106	0.097	0.058	4.215	4.508	0.872	0.085	0.881	0.061	1.393
392.8	12.5	7	6	0.058	1.212	7.743	7.809	0.094	0.058	4.360	4.809	0.866	0.081	0.861	0.062	1.306
390.3	15	6	6	0.057	1.356	6.437	6.497	0.084	0.057	4.504	5.109	0.860	0.072	0.840	0.062	1.161
387.8	17.5	11	6	0.062	1.505	11.484	11.568	0.127	0.062	4.653	5.414	0.855	0.109	0.820	0.062	1.758
385.3	20	6	50	0.057	1.654	6.122	12.346	0.134	0.057	4.802	5.719	0.849	0.114	0.800	0.062	NL
382.8	22.5	6	50	0.057	1.797	6.014	12.217	0.133	0.057	4.945	6.018	0.844	0.112	0.780	0.062	NL
380.3	25	27	6	0.070	1.956	26.547	26.701	0.330	0.070	5.104	6.333	0.839	0.277	0.759	0.061	N60cs>25
377.8	27.5	15	6	0.065	2.125	14.474	14.572	0.156	0.065	5.273	6.658	0.833	0.130	0.739	0.061	2.131
375.3	30	26	6	0.070	2.294	24.273	24.417	0.281	0.070	5.442	6.983	0.828	0.233	0.719	0.060	3.883
372.8	32.5	30	6	0.071	2.470	26.991	27.147	0.343	0.071	5.618	7.315	0.823	0.282	0.699	0.059	N60cs>25
370.3	35	23	6	0.068	2.644	20.001	20.125	0.217	0.068	5.792	7.645	0.818	0.178	0.678	0.058	3.069
367.8	37.5	27	6	0.070	2.817	22.747	22.884	0.255	0.070	5.965	7.974	0.813	0.207	0.658	0.057	3.632
365.3	40	31	6	0.071	2.993	25.337	25.486	0.302	0.071	6.141	8.306	0.808	0.244	0.638	0.056	N60cs>25
362.8	42.5	28	6	0.070	3.169	22.241	22.375	0.247	0.070	6.317	8.638	0.804	0.199	0.618	0.055	3.618
360.3	45	22	6	0.068	3.342	17.016	17.126	0.182	0.068	6.490	8.967	0.799	0.145	0.597	0.054	2.685
357.8	47.5	29	6	0.071	3.516	21.869	22.001	0.242	0.071	6.664	9.297	0.795	0.192	0.577	0.052	3.692
355.3	50	34	6	0.072	3.695	25.010	25.157	0.295	0.072	6.843	9.632	0.791	0.233	0.557	0.051	N60cs>25
352.8	52.5	32	6	0.071	3.874	22.989	23.127	0.259	0.071	7.022	9.967	0.787	0.204	0.537	0.050	4.080
350.3	55	32	6	0.071	4.052	21.823	21.955	0.241	0.071	7.200	10.301	0.783	0.189	0.516	0.048	3.938
347.8	57.5	30	6	0.071	4.230	19.910	20.033	0.216	0.071	7.378	10.635	0.779	0.168	0.496	0.046	3.652
345.3	60	30	6	0.071	4.408	19.389	19.510	0.209	0.071	7.556	10.969	0.776	0.162	0.476	0.045	3.600
342.8	62.5	27	6	0.070	4.584	17.010	17.120	0.182	0.070	7.732	11.301	0.772	0.141	0.456	0.043	3.279
340.3	65	49	6	0.076	4.767	30.082	30.253	1.000	0.076	7.915	11.640	0.768	0.768	0.435	0.042	N60cs>25
337.8	67.5	58	6	0.077	4.958	34.683	34.876	1.000	0.077	8.106	11.987	0.765	0.765	0.415	0.040	N60cs>25
335.3	70	54	6	0.076	5.149	31.474	31.651	1.000	0.076	8.297	12.334	0.761	0.761	0.395	0.038	N60cs>25
332.8	72.5	46	6	0.075	5.338	26.157	26.310	0.320	0.075	8.486	12.679	0.758	0.243	0.375	0.036	N60cs>25
330.3	75	29	6	0.071	5.521	16.109	16.214	0.172	0.071	8.669	13.018	0.755	0.130	0.354	0.035	3.714
327.8	77.5	24	12	0.069	5.696	13.043	15.008	0.160	0.069	8.844	13.349	0.752	0.120	0.334	0.033	3.636
325.3	80	15	12	0.065	5.864	7.986	9.792	0.111	0.065	9.012	13.673	0.749	0.083	0.314	0.031	2.677

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-08** **1000 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.30** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **31.49** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.190** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **5.6** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **26.19** FT. (Which is 3.1428 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(Kα)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 2.112</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (Kσ)(Kα)(MSF)					
402.8	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	3.588	3.588	1.901	0.264	0.934	0.115	ABO. WAT.	
400.3	5	5	50	0.111	0.578	6.753	13.104	0.142	0.111	3.866	3.866	1.873	0.266	0.921	0.114	ABO. WAT.	
397.8	7.5	5	50	0.111	0.856	6.241	12.489	0.136	0.055	4.074	4.211	1.853	0.252	0.901	0.115	NL	
395.3	10	7	6	0.058	1.067	8.039	8.106	0.097	0.058	4.215	4.508	1.841	0.179	0.881	0.116	1.543	
392.8	12.5	7	6	0.058	1.212	7.743	7.809	0.094	0.058	4.360	4.809	1.828	0.172	0.861	0.117	1.470	
390.3	15	6	6	0.057	1.356	6.437	6.497	0.084	0.057	4.504	5.109	1.817	0.153	0.840	0.118	1.297	
387.8	17.5	11	6	0.062	1.505	11.484	11.568	0.127	0.062	4.653	5.414	1.805	0.229	0.820	0.118	1.941	
385.3	20	6	50	0.057	1.654	6.122	12.346	0.134	0.057	4.802	5.719	1.793	0.240	0.800	0.118	NL	
382.8	22.5	6	50	0.057	1.797	6.014	12.217	0.133	0.057	4.945	6.018	1.783	0.237	0.780	0.117	NL	
380.3	25	27	6	0.070	1.956	26.547	26.701	0.330	0.070	5.104	6.333	1.772	0.585	0.759	0.116	N60cs>25	
377.8	27.5	15	6	0.065	2.125	14.474	14.572	0.156	0.065	5.273	6.658	1.760	0.275	0.739	0.115	2.391	
375.3	30	26	6	0.070	2.294	24.273	24.417	0.281	0.070	5.442	6.983	1.749	0.491	0.719	0.114	4.307	
372.8	32.5	30	6	0.071	2.470	26.991	27.147	0.343	0.071	5.618	7.315	1.738	0.596	0.699	0.112	N60cs>25	
370.3	35	23	6	0.068	2.644	20.001	20.125	0.217	0.068	5.792	7.645	1.727	0.375	0.678	0.111	3.378	
367.8	37.5	27	6	0.070	2.817	22.747	22.884	0.255	0.070	5.965	7.974	1.717	0.438	0.658	0.109	4.018	
365.3	40	31	6	0.071	2.993	25.337	25.486	0.302	0.071	6.141	8.306	1.707	0.516	0.638	0.107	N60cs>25	
362.8	42.5	28	6	0.070	3.169	22.241	22.375	0.247	0.070	6.317	8.638	1.698	0.419	0.618	0.104	4.029	
360.3	45	22	6	0.068	3.342	17.016	17.126	0.182	0.068	6.490	8.967	1.689	0.307	0.597	0.102	3.010	
357.8	47.5	29	6	0.071	3.516	21.869	22.001	0.242	0.071	6.664	9.297	1.680	0.407	0.577	0.099	4.111	
355.3	50	34	6	0.072	3.695	25.010	25.157	0.295	0.072	6.843	9.632	1.671	0.493	0.557	0.097	N60cs>25	
352.8	52.5	32	6	0.071	3.874	22.989	23.127	0.259	0.071	7.022	9.967	1.662	0.430	0.537	0.094	4.574	
350.3	55	32	6	0.071	4.052	21.823	21.955	0.241	0.071	7.200	10.301	1.654	0.399	0.516	0.091	4.385	
347.8	57.5	30	6	0.071	4.230	19.910	20.033	0.216	0.071	7.378	10.635	1.646	0.356	0.496	0.088	4.045	
345.3	60	30	6	0.071	4.408	19.389	19.510	0.209	0.071	7.556	10.969	1.638	0.342	0.476	0.085	4.024	
342.8	62.5	27	6	0.070	4.584	17.010	17.120	0.182	0.070	7.732	11.301	1.630	0.297	0.456	0.082	3.622	
340.3	65	49	6	0.076	4.767	30.082	30.253	1.000	0.076	7.915	11.640	1.623	1.623	0.435	0.079	N60cs>25	
337.8	67.5	58	6	0.077	4.958	34.683	34.876	1.000	0.077	8.106	11.987	1.615	1.615	0.415	0.076	N60cs>25	
335.3	70	54	6	0.076	5.149	31.474	31.651	1.000	0.076	8.297	12.334	1.608	1.608	0.395	0.073	N60cs>25	
332.8	72.5	46	6	0.075	5.338	26.157	26.310	0.320	0.075	8.486	12.679	1.600	0.512	0.375	0.069	N60cs>25	
330.3	75	29	6	0.071	5.521	16.109	16.214	0.172	0.071	8.669	13.018	1.594	0.274	0.354	0.066	4.152	
327.8	77.5	24	12	0.069	5.696	13.043	15.008	0.160	0.069	8.844	13.349	1.587	0.254	0.334	0.062	4.097	
325.3	80	15	12	0.065	5.864	7.986	9.792	0.111	0.065	9.012	13.673	1.581	0.175	0.314	0.059	2.966	

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-08** **2500 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.30** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **31.49** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.120** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.7** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **26.19** FT. (Which is 3.1428 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<math>\alpha</math>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 0.935</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K $\sigma$ )(K $\alpha$ )(MSF)				
402.8	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	3.588	3.588	0.842	0.117	0.934	0.073	ABO. WAT.
400.3	5	5	50	0.111	0.578	6.753	13.104	0.142	0.111	3.866	3.866	0.829	0.118	0.921	0.072	ABO. WAT.
397.8	7.5	5	50	0.111	0.856	6.241	12.489	0.136	0.055	4.074	4.211	0.820	0.112	0.901	0.073	NL
395.3	10	7	6	0.058	1.067	8.039	8.106	0.097	0.058	4.215	4.508	0.815	0.079	0.881	0.073	1.082
392.8	12.5	7	6	0.058	1.212	7.743	7.809	0.094	0.058	4.360	4.809	0.809	0.076	0.861	0.074	1.027
390.3	15	6	6	0.057	1.356	6.437	6.497	0.084	0.057	4.504	5.109	0.804	0.068	0.840	0.074	0.919
387.8	17.5	11	6	0.062	1.505	11.484	11.568	0.127	0.062	4.653	5.414	0.799	0.101	0.820	0.074	1.365
385.3	20	6	50	0.057	1.654	6.122	12.346	0.134	0.057	4.802	5.719	0.794	0.106	0.800	0.074	NL
382.8	22.5	6	50	0.057	1.797	6.014	12.217	0.133	0.057	4.945	6.018	0.789	0.105	0.780	0.074	NL
380.3	25	27	6	0.070	1.956	26.547	26.701	0.330	0.070	5.104	6.333	0.784	0.259	0.759	0.073	N60cs>25
377.8	27.5	15	6	0.065	2.125	14.474	14.572	0.156	0.065	5.273	6.658	0.779	0.122	0.739	0.073	1.671
375.3	30	26	6	0.070	2.294	24.273	24.417	0.281	0.070	5.442	6.983	0.774	0.217	0.719	0.072	3.014
372.8	32.5	30	6	0.071	2.470	26.991	27.147	0.343	0.071	5.618	7.315	0.769	0.264	0.699	0.071	N60cs>25
370.3	35	23	6	0.068	2.644	20.001	20.125	0.217	0.068	5.792	7.645	0.765	0.166	0.678	0.070	2.371
367.8	37.5	27	6	0.070	2.817	22.747	22.884	0.255	0.070	5.965	7.974	0.760	0.194	0.658	0.069	2.812
365.3	40	31	6	0.071	2.993	25.337	25.486	0.302	0.071	6.141	8.306	0.756	0.228	0.638	0.067	N60cs>25
362.8	42.5	28	6	0.070	3.169	22.241	22.375	0.247	0.070	6.317	8.638	0.752	0.186	0.618	0.066	2.818
360.3	45	22	6	0.068	3.342	17.016	17.126	0.182	0.068	6.490	8.967	0.748	0.136	0.597	0.064	2.125
357.8	47.5	29	6	0.071	3.516	21.869	22.001	0.242	0.071	6.664	9.297	0.744	0.180	0.577	0.063	2.857
355.3	50	34	6	0.072	3.695	25.010	25.157	0.295	0.072	6.843	9.632	0.740	0.218	0.557	0.061	N60cs>25
352.8	52.5	32	6	0.071	3.874	22.989	23.127	0.259	0.071	7.022	9.967	0.736	0.191	0.537	0.059	3.237
350.3	55	32	6	0.071	4.052	21.823	21.955	0.241	0.071	7.200	10.301	0.732	0.176	0.516	0.058	3.034
347.8	57.5	30	6	0.071	4.230	19.910	20.033	0.216	0.071	7.378	10.635	0.729	0.157	0.496	0.056	2.804
345.3	60	30	6	0.071	4.408	19.389	19.510	0.209	0.071	7.556	10.969	0.725	0.152	0.476	0.054	2.815
342.8	62.5	27	6	0.070	4.584	17.010	17.120	0.182	0.070	7.732	11.301	0.722	0.131	0.456	0.052	2.519
340.3	65	49	6	0.076	4.767	30.082	30.253	1.000	0.076	7.915	11.640	0.718	0.178	0.435	0.050	N60cs>25
337.8	67.5	58	6	0.077	4.958	34.683	34.876	1.000	0.077	8.106	11.987	0.715	0.175	0.415	0.048	N60cs>25
335.3	70	54	6	0.076	5.149	31.474	31.651	1.000	0.076	8.297	12.334	0.712	0.172	0.395	0.046	N60cs>25
332.8	72.5	46	6	0.075	5.338	26.157	26.310	0.320	0.075	8.486	12.679	0.708	0.227	0.375	0.044	N60cs>25
330.3	75	29	6	0.071	5.521	16.109	16.214	0.172	0.071	8.669	13.018	0.705	0.121	0.354	0.041	2.951
327.8	77.5	24	12	0.069	5.696	13.043	15.008	0.160	0.069	8.844	13.349	0.703	0.112	0.334	0.039	2.872
325.3	80	15	12	0.065	5.864	7.986	9.792	0.111	0.065	9.012	13.673	0.700	0.078	0.314	0.037	2.108

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-08** **2500 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.30** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **31.49** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.260** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **6.0** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **26.19** FT. (Which is 3.1428 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor	<b>(K<math>\alpha</math>)= 1.00</b>
Earthquake Magnitude Scaling Factor	<b>(MSF)= 1.770</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value N (Blows)	% Fines < #200 (%)		Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> )60	Fines Content Corrected (N <sub>1</sub> )60cs	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)				
402.8	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	3.588	3.588	1.593	0.221	0.934	0.158	ABO. WAT.
400.3	5	5	50	0.111	0.578	6.753	13.104	0.142	0.111	3.866	3.866	1.570	0.223	0.921	0.156	ABO. WAT.
397.8	7.5	5	50	0.111	0.856	6.241	12.489	0.136	0.055	4.074	4.211	1.553	0.211	0.901	0.157	NL
395.3	10	7	6	0.058	1.067	8.039	8.106	0.097	0.058	4.215	4.508	1.543	0.150	0.881	0.159	0.943
392.8	12.5	7	6	0.058	1.212	7.743	7.809	0.094	0.058	4.360	4.809	1.532	0.144	0.861	0.160	0.900
390.3	15	6	6	0.057	1.356	6.437	6.497	0.084	0.057	4.504	5.109	1.522	0.128	0.840	0.161	0.795
387.8	17.5	11	6	0.062	1.505	11.484	11.568	0.127	0.062	4.653	5.414	1.512	0.192	0.820	0.161	1.193
385.3	20	6	50	0.057	1.654	6.122	12.346	0.134	0.057	4.802	5.719	1.503	0.201	0.800	0.161	NL
382.8	22.5	6	50	0.057	1.797	6.014	12.217	0.133	0.057	4.945	6.018	1.494	0.199	0.780	0.160	NL
380.3	25	27	6	0.070	1.956	26.547	26.701	0.330	0.070	5.104	6.333	1.485	0.490	0.759	0.159	N60cs>25
377.8	27.5	15	6	0.065	2.125	14.474	14.572	0.156	0.065	5.273	6.658	1.475	0.230	0.739	0.158	1.456
375.3	30	26	6	0.070	2.294	24.273	24.417	0.281	0.070	5.442	6.983	1.466	0.412	0.719	0.156	2.641
372.8	32.5	30	6	0.071	2.470	26.991	27.147	0.343	0.071	5.618	7.315	1.457	0.500	0.699	0.154	N60cs>25
370.3	35	23	6	0.068	2.644	20.001	20.125	0.217	0.068	5.792	7.645	1.448	0.314	0.678	0.151	2.079
367.8	37.5	27	6	0.070	2.817	22.747	22.884	0.255	0.070	5.965	7.974	1.439	0.367	0.658	0.149	2.463
365.3	40	31	6	0.071	2.993	25.337	25.486	0.302	0.071	6.141	8.306	1.431	0.432	0.638	0.146	N60cs>25
362.8	42.5	28	6	0.070	3.169	22.241	22.375	0.247	0.070	6.317	8.638	1.423	0.351	0.618	0.143	2.455
360.3	45	22	6	0.068	3.342	17.016	17.126	0.182	0.068	6.490	8.967	1.415	0.258	0.597	0.139	1.856
357.8	47.5	29	6	0.071	3.516	21.869	22.001	0.242	0.071	6.664	9.297	1.408	0.341	0.577	0.136	2.507
355.3	50	34	6	0.072	3.695	25.010	25.157	0.295	0.072	6.843	9.632	1.400	0.413	0.557	0.132	N60cs>25
352.8	52.5	32	6	0.071	3.874	22.989	23.127	0.259	0.071	7.022	9.967	1.393	0.361	0.537	0.129	2.798
350.3	55	32	6	0.071	4.052	21.823	21.955	0.241	0.071	7.200	10.301	1.386	0.334	0.516	0.125	2.672
347.8	57.5	30	6	0.071	4.230	19.910	20.033	0.216	0.071	7.378	10.635	1.379	0.298	0.496	0.121	2.463
345.3	60	30	6	0.071	4.408	19.389	19.510	0.209	0.071	7.556	10.969	1.373	0.287	0.476	0.117	2.453
342.8	62.5	27	6	0.070	4.584	17.010	17.120	0.182	0.070	7.732	11.301	1.366	0.249	0.456	0.113	2.204
340.3	65	49	6	0.076	4.767	30.082	30.253	1.000	0.076	7.915	11.640	1.360	1.360	0.435	0.108	N60cs>25
337.8	67.5	58	6	0.077	4.958	34.683	34.876	1.000	0.077	8.106	11.987	1.354	1.354	0.415	0.104	N60cs>25
335.3	70	54	6	0.076	5.149	31.474	31.651	1.000	0.076	8.297	12.334	1.347	1.347	0.395	0.099	N60cs>25
332.8	72.5	46	6	0.075	5.338	26.157	26.310	0.320	0.075	8.486	12.679	1.341	0.429	0.375	0.095	N60cs>25
330.3	75	29	6	0.071	5.521	16.109	16.214	0.172	0.071	8.669	13.018	1.336	0.230	0.354	0.090	2.556
327.8	77.5	24	12	0.069	5.696	13.043	15.008	0.160	0.069	8.844	13.349	1.330	0.213	0.334	0.085	2.506
325.3	80	15	12	0.065	5.864	7.986	9.792	0.111	0.065	9.012	13.673	1.325	0.147	0.314	0.081	1.815

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-09** **1000 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **404.80** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **29.99** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.100** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.5** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **25.19** FT. (Which is 3.0228 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor	<b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor	<b>(MSF)= 1.000</b>

Elev. of Sample (Feet)	Boring Data			Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
402.3	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	3.442	3.442	0.908	0.126	0.936	0.061	ABO. WAT.
399.8	5	6	50	0.113	0.580	8.104	14.725	0.157	0.057	3.652	3.664	0.897	0.141	0.929	0.061	NL
397.3	7.5	5	50	0.111	0.860	6.227	12.472	0.136	0.055	3.792	3.960	0.890	0.121	0.909	0.062	NL
394.8	10	6	50	0.057	1.070	6.881	13.257	0.143	0.057	3.932	4.256	0.884	0.126	0.889	0.063	NL
392.3	12.5	0	50	0.031	1.180	0.000	5.000	0.072	0.031	4.042	4.522	0.879	0.063	0.869	0.063	NL
389.8	15	4	12	0.054	1.286	4.407	6.100	0.080	0.054	4.148	4.784	0.874	0.070	0.848	0.064	1.094
387.3	17.5	5	12	0.055	1.422	5.370	7.093	0.088	0.055	4.284	5.076	0.869	0.076	0.828	0.064	1.188
384.8	20	8	50	0.059	1.565	8.391	15.069	0.161	0.059	4.427	5.375	0.863	0.139	0.808	0.064	NL
382.3	22.5	4	50	0.054	1.706	4.115	9.938	0.113	0.054	4.568	5.672	0.858	0.097	0.788	0.064	NL
379.8	25	25	5	0.069	1.860	25.207	25.207	0.296	0.069	4.722	5.982	0.852	0.252	0.767	0.063	N60cs>25
377.3	27.5	20	5	0.067	2.030	19.744	19.744	0.212	0.067	4.892	6.308	0.846	0.179	0.747	0.063	2.841
374.8	30	27	5	0.070	2.201	25.734	25.734	0.307	0.070	5.063	6.635	0.840	0.258	0.727	0.062	N60cs>25
372.3	32.5	38	5	0.073	2.380	34.829	34.829	1.000	0.073	5.242	6.970	0.834	0.834	0.707	0.061	N60cs>25
369.8	35	35	5	0.072	2.561	30.925	30.925	1.000	0.072	5.423	7.307	0.829	0.829	0.686	0.060	N60cs>25
367.3	37.5	27	5	0.070	2.739	23.068	23.068	0.258	0.070	5.601	7.641	0.823	0.212	0.666	0.059	3.593
364.8	40	26	5	0.070	2.914	21.537	21.537	0.236	0.070	5.776	7.972	0.818	0.193	0.646	0.058	3.328
362.3	42.5	25	5	0.069	3.088	20.116	20.116	0.217	0.069	5.950	8.302	0.814	0.177	0.626	0.057	3.105
359.8	45	21	5	0.068	3.259	16.449	16.449	0.175	0.068	6.121	8.629	0.809	0.142	0.605	0.055	2.582
357.3	47.5	18	5	0.066	3.427	13.749	13.749	0.148	0.066	6.289	8.953	0.805	0.119	0.585	0.054	2.204
354.8	50	29	5	0.071	3.598	21.618	21.618	0.237	0.071	6.460	9.280	0.800	0.190	0.565	0.053	3.585
352.3	52.5	24	5	0.069	3.773	17.471	17.471	0.186	0.069	6.635	9.611	0.796	0.148	0.545	0.051	2.902
349.8	55	21	5	0.068	3.944	14.952	14.952	0.160	0.068	6.806	9.938	0.792	0.127	0.524	0.050	2.540
347.3	57.5	11	5	0.062	4.107	7.438	7.438	0.091	0.062	6.969	10.257	0.788	0.072	0.504	0.048	1.500
344.8	60	18	5	0.066	4.267	11.879	11.879	0.130	0.066	7.129	10.573	0.785	0.102	0.484	0.047	2.170
342.3	62.5	23	5	0.068	4.435	14.806	14.806	0.158	0.068	7.297	10.897	0.781	0.123	0.464	0.045	2.733
339.8	65	22	5	0.068	4.605	13.819	13.819	0.148	0.068	7.467	11.223	0.777	0.115	0.443	0.043	2.674
337.3	67.5	17	12	0.066	4.773	10.428	12.311	0.134	0.066	7.635	11.547	0.774	0.104	0.423	0.042	2.476
334.8	70	45	5	0.075	4.949	26.942	26.942	0.337	0.075	7.811	11.879	0.770	0.259	0.403	0.040	N60cs>25
332.3	72.5	27	4	0.070	5.130	15.777	15.777	0.168	0.070	7.992	12.216	0.767	0.129	0.383	0.038	3.395
329.8	75	64	4	0.078	5.315	36.500	36.500	1.000	0.078	8.177	12.557	0.763	0.763	0.362	0.036	N60cs>25
327.3	77.5	52	5	0.076	5.508	28.933	28.933	0.407	0.076	8.370	12.906	0.760	0.309	0.342	0.034	N60cs>25
324.8	80	16	12	0.065	5.684	8.709	10.538	0.118	0.065	8.546	13.238	0.757	0.089	0.322	0.032	2.781

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction



# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-09** **1000 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **404.80** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **29.99** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.190** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **5.6** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **25.19** FT. (Which is 3.0228 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 2.112</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)		Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)				
402.3	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	3.442	3.442	1.917	0.266	0.936	0.116	ABO. WAT.
399.8	5	6	50	0.113	0.580	8.104	14.725	0.157	0.057	3.652	3.664	1.894	0.297	0.929	0.115	NL
397.3	7.5	5	50	0.111	0.860	6.227	12.472	0.136	0.055	3.792	3.960	1.880	0.256	0.909	0.117	NL
394.8	10	6	50	0.057	1.070	6.881	13.257	0.143	0.057	3.932	4.256	1.867	0.267	0.889	0.119	NL
392.3	12.5	0	50	0.031	1.180	0.000	5.000	0.072	0.031	4.042	4.522	1.856	0.134	0.869	0.120	NL
389.8	15	4	12	0.054	1.286	4.407	6.100	0.080	0.054	4.148	4.784	1.847	0.148	0.848	0.121	1.223
387.3	17.5	5	12	0.055	1.422	5.370	7.093	0.088	0.055	4.284	5.076	1.835	0.161	0.828	0.121	1.331
384.8	20	8	50	0.059	1.565	8.391	15.069	0.161	0.059	4.427	5.375	1.823	0.294	0.808	0.121	NL
382.3	22.5	4	50	0.054	1.706	4.115	9.938	0.113	0.054	4.568	5.672	1.811	0.205	0.788	0.121	NL
379.8	25	25	5	0.069	1.860	25.207	25.207	0.296	0.069	4.722	5.982	1.799	0.533	0.767	0.120	N60cs>25
377.3	27.5	20	5	0.067	2.030	19.744	19.744	0.212	0.067	4.892	6.308	1.787	0.379	0.747	0.119	3.185
374.8	30	27	5	0.070	2.201	25.734	25.734	0.307	0.070	5.063	6.635	1.775	0.545	0.727	0.118	N60cs>25
372.3	32.5	38	5	0.073	2.380	34.829	34.829	1.000	0.073	5.242	6.970	1.762	1.762	0.707	0.116	N60cs>25
369.8	35	35	5	0.072	2.561	30.925	30.925	1.000	0.072	5.423	7.307	1.750	1.750	0.686	0.114	N60cs>25
367.3	37.5	27	5	0.070	2.739	23.068	23.068	0.258	0.070	5.601	7.641	1.739	0.449	0.666	0.112	4.009
364.8	40	26	5	0.070	2.914	21.537	21.537	0.236	0.070	5.776	7.972	1.728	0.408	0.646	0.110	3.709
362.3	42.5	25	5	0.069	3.088	20.116	20.116	0.217	0.069	5.950	8.302	1.718	0.373	0.626	0.108	3.454
359.8	45	21	5	0.068	3.259	16.449	16.449	0.175	0.068	6.121	8.629	1.708	0.299	0.605	0.105	2.848
357.3	47.5	18	5	0.066	3.427	13.749	13.749	0.148	0.066	6.289	8.953	1.699	0.251	0.585	0.103	2.437
354.8	50	29	5	0.071	3.598	21.618	21.618	0.237	0.071	6.460	9.280	1.690	0.401	0.565	0.100	4.010
352.3	52.5	24	5	0.069	3.773	17.471	17.471	0.186	0.069	6.635	9.611	1.681	0.313	0.545	0.097	3.227
349.8	55	21	5	0.068	3.944	14.952	14.952	0.160	0.068	6.806	9.938	1.673	0.268	0.524	0.094	2.851
347.3	57.5	11	5	0.062	4.107	7.438	7.438	0.091	0.062	6.969	10.257	1.665	0.152	0.504	0.092	1.652
344.8	60	18	5	0.066	4.267	11.879	11.879	0.130	0.066	7.129	10.573	1.657	0.215	0.484	0.089	2.416
342.3	62.5	23	5	0.068	4.435	14.806	14.806	0.158	0.068	7.297	10.897	1.649	0.261	0.464	0.086	3.035
339.8	65	22	5	0.068	4.605	13.819	13.819	0.148	0.068	7.467	11.223	1.642	0.243	0.443	0.082	2.963
337.3	67.5	17	12	0.066	4.773	10.428	12.311	0.134	0.066	7.635	11.547	1.635	0.219	0.423	0.079	2.772
334.8	70	45	5	0.075	4.949	26.942	26.942	0.337	0.075	7.811	11.879	1.627	0.548	0.403	0.076	N60cs>25
332.3	72.5	27	4	0.070	5.130	15.777	15.777	0.168	0.070	7.992	12.216	1.620	0.272	0.383	0.072	3.778
329.8	75	64	4	0.078	5.315	36.500	36.500	1.000	0.078	8.177	12.557	1.612	1.612	0.362	0.069	N60cs>25
327.3	77.5	52	5	0.076	5.508	28.933	28.933	0.407	0.076	8.370	12.906	1.605	0.653	0.342	0.065	N60cs>25
324.8	80	16	12	0.065	5.684	8.709	10.538	0.118	0.065	8.546	13.238	1.598	0.189	0.322	0.062	3.048

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-09** **2500 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **404.80** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **29.99** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.120** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.7** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **25.19** FT. (Which is 3.0228 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(Kα)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 0.935</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> )60	Fines Content Corrected (N <sub>1</sub> )60cs	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (Kσ)(Kα)(MSF)					
402.3	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	3.442	3.442	0.849	<b>0.118</b>	0.936	<b>0.073</b>	ABO. WAT.	
399.8	5	6	50	0.113	0.580	8.104	14.725	0.157	0.057	3.652	3.664	0.839	<b>0.132</b>	0.929	<b>0.073</b>	NL	
397.3	7.5	5	50	0.111	0.860	6.227	12.472	0.136	0.055	3.792	3.960	0.832	<b>0.113</b>	0.909	<b>0.074</b>	NL	
394.8	10	6	50	0.057	1.070	6.881	13.257	0.143	0.057	3.932	4.256	0.826	<b>0.118</b>	0.889	<b>0.075</b>	NL	
392.3	12.5	0	50	0.031	1.180	0.000	5.000	0.072	0.031	4.042	4.522	0.822	<b>0.059</b>	0.869	<b>0.076</b>	NL	
389.8	15	4	12	0.054	1.286	4.407	6.100	0.080	0.054	4.148	4.784	0.818	<b>0.065</b>	0.848	<b>0.076</b>	<b>0.855</b>	
387.3	17.5	5	12	0.055	1.422	5.370	7.093	0.088	0.055	4.284	5.076	0.812	<b>0.071</b>	0.828	<b>0.077</b>	<b>0.922</b>	
384.8	20	8	50	0.059	1.565	8.391	15.069	0.161	0.059	4.427	5.375	0.807	<b>0.130</b>	0.808	<b>0.077</b>	NL	
382.3	22.5	4	50	0.054	1.706	4.115	9.938	0.113	0.054	4.568	5.672	0.802	<b>0.091</b>	0.788	<b>0.076</b>	NL	
379.8	25	25	5	0.069	1.860	25.207	25.207	0.296	0.069	4.722	5.982	0.797	<b>0.236</b>	0.767	<b>0.076</b>	N60cs>25	
377.3	27.5	20	5	0.067	2.030	19.744	19.744	0.212	0.067	4.892	6.308	0.791	<b>0.168</b>	0.747	<b>0.075</b>	2.240	
374.8	30	27	5	0.070	2.201	25.734	25.734	0.307	0.070	5.063	6.635	0.786	<b>0.241</b>	0.727	<b>0.074</b>	N60cs>25	
372.3	32.5	38	5	0.073	2.380	34.829	34.829	1.000	0.073	5.242	6.970	0.780	<b>0.780</b>	0.707	<b>0.073</b>	N60cs>25	
369.8	35	35	5	0.072	2.561	30.925	30.925	1.000	0.072	5.423	7.307	0.775	<b>0.775</b>	0.686	<b>0.072</b>	N60cs>25	
367.3	37.5	27	5	0.070	2.739	23.068	23.068	0.258	0.070	5.601	7.641	0.770	<b>0.199</b>	0.666	<b>0.071</b>	2.803	
364.8	40	26	5	0.070	2.914	21.537	21.537	0.236	0.070	5.776	7.972	0.765	<b>0.181</b>	0.646	<b>0.070</b>	2.586	
362.3	42.5	25	5	0.069	3.088	20.116	20.116	0.217	0.069	5.950	8.302	0.761	<b>0.165</b>	0.626	<b>0.068</b>	2.426	
359.8	45	21	5	0.068	3.259	16.449	16.449	0.175	0.068	6.121	8.629	0.756	<b>0.132</b>	0.605	<b>0.067</b>	1.970	
357.3	47.5	18	5	0.066	3.427	13.749	13.749	0.148	0.066	6.289	8.953	0.752	<b>0.111</b>	0.585	<b>0.065</b>	1.708	
354.8	50	29	5	0.071	3.598	21.618	21.618	0.237	0.071	6.460	9.280	0.748	<b>0.177</b>	0.565	<b>0.063</b>	2.810	
352.3	52.5	24	5	0.069	3.773	17.471	17.471	0.186	0.069	6.635	9.611	0.744	<b>0.138</b>	0.545	<b>0.062</b>	2.226	
349.8	55	21	5	0.068	3.944	14.952	14.952	0.160	0.068	6.806	9.938	0.740	<b>0.118</b>	0.524	<b>0.060</b>	1.967	
347.3	57.5	11	5	0.062	4.107	7.438	7.438	0.091	0.062	6.969	10.257	0.737	<b>0.067</b>	0.504	<b>0.058</b>	1.155	
344.8	60	18	5	0.066	4.267	11.879	11.879	0.130	0.066	7.129	10.573	0.734	<b>0.095</b>	0.484	<b>0.056</b>	1.696	
342.3	62.5	23	5	0.068	4.435	14.806	14.806	0.158	0.068	7.297	10.897	0.730	<b>0.115</b>	0.464	<b>0.054</b>	2.130	
339.8	65	22	5	0.068	4.605	13.819	13.819	0.148	0.068	7.467	11.223	0.727	<b>0.108</b>	0.443	<b>0.052</b>	2.077	
337.3	67.5	17	12	0.066	4.773	10.428	12.311	0.134	0.066	7.635	11.547	0.724	<b>0.097</b>	0.423	<b>0.050</b>	1.940	
334.8	70	45	5	0.075	4.949	26.942	26.942	0.337	0.075	7.811	11.879	0.720	<b>0.243</b>	0.403	<b>0.048</b>	N60cs>25	
332.3	72.5	27	4	0.070	5.130	15.777	15.777	0.168	0.070	7.992	12.216	0.717	<b>0.120</b>	0.383	<b>0.046</b>	2.609	
329.8	75	64	4	0.078	5.315	36.500	36.500	1.000	0.078	8.177	12.557	0.714	<b>0.714</b>	0.362	<b>0.043</b>	N60cs>25	
327.3	77.5	52	5	0.076	5.508	28.933	28.933	0.407	0.076	8.370	12.906	0.710	<b>0.289</b>	0.342	<b>0.041</b>	N60cs>25	
324.8	80	16	12	0.065	5.684	8.709	10.538	0.118	0.065	8.546	13.238	0.707	<b>0.083</b>	0.322	<b>0.039</b>	2.128	

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-09** **2500 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **404.80** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **29.99** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.260** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **6.0** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **25.19** FT. (Which is 3.0228 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor	<b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor	<b>(MSF)= 1.770</b>

Elev. of Sample (Feet)	Boring Data			Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
402.3	2.5	5	50	0.111	0.300	6.564	12.877	0.139	0.111	3.442	3.442	1.606	<b>0.223</b>	0.936	<b>0.158</b>	<b>ABO. WAT.</b>
399.8	5	6	50	0.113	0.580	8.104	14.725	0.157	0.057	3.652	3.664	1.588	<b>0.249</b>	0.929	<b>0.158</b>	<b>NL</b>
397.3	7.5	5	50	0.111	0.860	6.227	12.472	0.136	0.055	3.792	3.960	1.576	<b>0.214</b>	0.909	<b>0.160</b>	<b>NL</b>
394.8	10	6	50	0.057	1.070	6.881	13.257	0.143	0.057	3.932	4.256	1.564	<b>0.224</b>	0.889	<b>0.163</b>	<b>NL</b>
392.3	12.5	0	50	0.031	1.180	0.000	5.000	0.072	0.031	4.042	4.522	1.556	<b>0.112</b>	0.869	<b>0.164</b>	<b>NL</b>
389.8	15	4	12	0.054	1.286	4.407	6.100	0.080	0.054	4.148	4.784	1.548	<b>0.124</b>	0.848	<b>0.165</b>	<b>0.752</b>
387.3	17.5	5	12	0.055	1.422	5.370	7.093	0.088	0.055	4.284	5.076	1.538	<b>0.135</b>	0.828	<b>0.166</b>	<b>0.813</b>
384.8	20	8	50	0.059	1.565	8.391	15.069	0.161	0.059	4.427	5.375	1.528	<b>0.246</b>	0.808	<b>0.166</b>	<b>NL</b>
382.3	22.5	4	50	0.054	1.706	4.115	9.938	0.113	0.054	4.568	5.672	1.518	<b>0.172</b>	0.788	<b>0.165</b>	<b>NL</b>
379.8	25	25	5	0.069	1.860	25.207	25.207	0.296	0.069	4.722	5.982	1.508	<b>0.446</b>	0.767	<b>0.164</b>	<b>N60cs&gt;25</b>
377.3	27.5	20	5	0.067	2.030	19.744	19.744	0.212	0.067	4.892	6.308	1.497	<b>0.317</b>	0.747	<b>0.163</b>	<b>1.945</b>
374.8	30	27	5	0.070	2.201	25.734	25.734	0.307	0.070	5.063	6.635	1.487	<b>0.457</b>	0.727	<b>0.161</b>	<b>N60cs&gt;25</b>
372.3	32.5	38	5	0.073	2.380	34.829	34.829	1.000	0.073	5.242	6.970	1.477	<b>1.477</b>	0.707	<b>0.159</b>	<b>N60cs&gt;25</b>
369.8	35	35	5	0.072	2.561	30.925	30.925	1.000	0.072	5.423	7.307	1.467	<b>1.467</b>	0.686	<b>0.156</b>	<b>N60cs&gt;25</b>
367.3	37.5	27	5	0.070	2.739	23.068	23.068	0.258	0.070	5.601	7.641	1.457	<b>0.376</b>	0.666	<b>0.154</b>	<b>2.442</b>
364.8	40	26	5	0.070	2.914	21.537	21.537	0.236	0.070	5.776	7.972	1.448	<b>0.342</b>	0.646	<b>0.151</b>	<b>2.265</b>
362.3	42.5	25	5	0.069	3.088	20.116	20.116	0.217	0.069	5.950	8.302	1.440	<b>0.312</b>	0.626	<b>0.148</b>	<b>2.108</b>
359.8	45	21	5	0.068	3.259	16.449	16.449	0.175	0.068	6.121	8.629	1.432	<b>0.251</b>	0.605	<b>0.144</b>	<b>1.743</b>
357.3	47.5	18	5	0.066	3.427	13.749	13.749	0.148	0.066	6.289	8.953	1.424	<b>0.211</b>	0.585	<b>0.141</b>	<b>1.496</b>
354.8	50	29	5	0.071	3.598	21.618	21.618	0.237	0.071	6.460	9.280	1.416	<b>0.336</b>	0.565	<b>0.137</b>	<b>2.453</b>
352.3	52.5	24	5	0.069	3.773	17.471	17.471	0.186	0.069	6.635	9.611	1.409	<b>0.262</b>	0.545	<b>0.133</b>	<b>1.970</b>
349.8	55	21	5	0.068	3.944	14.952	14.952	0.160	0.068	6.806	9.938	1.402	<b>0.224</b>	0.524	<b>0.129</b>	<b>1.736</b>
347.3	57.5	11	5	0.062	4.107	7.438	7.438	0.091	0.062	6.969	10.257	1.395	<b>0.127</b>	0.504	<b>0.125</b>	<b>1.016</b>
344.8	60	18	5	0.066	4.267	11.879	11.879	0.130	0.066	7.129	10.573	1.389	<b>0.181</b>	0.484	<b>0.121</b>	<b>1.496</b>
342.3	62.5	23	5	0.068	4.435	14.806	14.806	0.158	0.068	7.297	10.897	1.382	<b>0.218</b>	0.464	<b>0.117</b>	<b>1.863</b>
339.8	65	22	5	0.068	4.605	13.819	13.819	0.148	0.068	7.467	11.223	1.376	<b>0.204</b>	0.443	<b>0.113</b>	<b>1.805</b>
337.3	67.5	17	12	0.066	4.773	10.428	12.311	0.134	0.066	7.635	11.547	1.370	<b>0.184</b>	0.423	<b>0.108</b>	<b>1.704</b>
334.8	70	45	5	0.075	4.949	26.942	26.942	0.337	0.075	7.811	11.879	1.364	<b>0.460</b>	0.403	<b>0.104</b>	<b>N60cs&gt;25</b>
332.3	72.5	27	4	0.070	5.130	15.777	15.777	0.168	0.070	7.992	12.216	1.357	<b>0.228</b>	0.383	<b>0.099</b>	<b>2.303</b>
329.8	75	64	4	0.078	5.315	36.500	36.500	1.000	0.078	8.177	12.557	1.351	<b>1.351</b>	0.362	<b>0.094</b>	<b>N60cs&gt;25</b>
327.3	77.5	52	5	0.076	5.508	28.933	28.933	0.407	0.076	8.370	12.906	1.345	<b>0.547</b>	0.342	<b>0.089</b>	<b>N60cs&gt;25</b>
324.8	80	16	12	0.065	5.684	8.709	10.538	0.118	0.065	8.546	13.238	1.339	<b>0.158</b>	0.322	<b>0.084</b>	<b>1.881</b>

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-10** **1000 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **404.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **28.49** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.100** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.5** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **23.79** FT. (Which is 2.8548 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.000</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)		Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> )60	Fines Content Corrected (N <sub>1</sub> )60cs	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)				
402.2	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	3.269	3.269	0.917	0.142	0.940	0.061	ABO. WAT.
399.7	5	5	50	0.111	0.580	6.753	13.104	0.142	0.055	3.479	3.498	0.906	0.129	0.934	0.061	NL
397.2	7.5	4	50	0.109	0.855	4.996	10.995	0.122	0.054	3.615	3.790	0.899	0.110	0.921	0.063	NL
394.7	10	5	12	0.055	1.060	5.761	7.496	0.092	0.055	3.751	4.082	0.892	0.082	0.900	0.064	1.281
392.2	12.5	7	12	0.058	1.201	7.779	9.578	0.109	0.058	3.892	4.379	0.886	0.097	0.880	0.064	1.516
389.7	15	9	12	0.060	1.349	9.680	11.539	0.127	0.060	4.040	4.683	0.879	0.112	0.860	0.065	1.723
387.2	17.5	13	5	0.063	1.503	13.581	13.581	0.146	0.063	4.194	4.993	0.872	0.127	0.840	0.065	1.954
384.7	20	6	50	0.057	1.653	6.124	12.349	0.134	0.057	4.344	5.299	0.866	0.116	0.819	0.065	NL
382.2	22.5	11	5	0.062	1.802	11.010	11.010	0.122	0.062	4.493	5.604	0.861	0.105	0.799	0.065	1.615
379.7	25	25	5	0.069	1.966	24.518	24.518	0.283	0.069	4.657	5.924	0.854	0.242	0.779	0.064	3.781
377.2	27.5	27	5	0.070	2.140	25.961	25.961	0.312	0.070	4.831	6.254	0.848	0.265	0.759	0.064	N60cs>25
374.7	30	13	5	0.063	2.306	12.105	12.105	0.132	0.063	4.997	6.576	0.842	0.111	0.738	0.063	1.762
372.2	32.5	23	5	0.068	2.470	20.693	20.693	0.224	0.068	5.161	6.896	0.837	0.187	0.718	0.062	3.016
369.7	35	23	5	0.068	2.640	20.016	20.016	0.216	0.068	5.331	7.222	0.832	0.180	0.698	0.061	2.951
367.2	37.5	17	5	0.066	2.808	14.345	14.345	0.154	0.066	5.499	7.546	0.826	0.127	0.678	0.060	2.117
364.7	40	19	5	0.067	2.974	15.579	15.579	0.166	0.067	5.665	7.868	0.822	0.136	0.657	0.059	2.305
362.2	42.5	17	5	0.066	3.140	13.565	13.565	0.146	0.066	5.831	8.190	0.817	0.119	0.637	0.058	2.052
359.7	45	16	5	0.065	3.304	12.447	12.447	0.135	0.065	5.995	8.510	0.812	0.110	0.617	0.057	1.930
357.2	47.5	18	5	0.066	3.468	13.667	13.667	0.147	0.066	6.159	8.830	0.808	0.119	0.597	0.056	2.125
354.7	50	27	5	0.070	3.638	20.016	20.016	0.216	0.070	6.329	9.156	0.804	0.174	0.576	0.054	3.222
352.2	52.5	41	5	0.074	3.818	29.670	29.670	0.446	0.074	6.509	9.492	0.799	0.356	0.556	0.053	N60cs>25
349.7	55	39	5	0.073	4.002	26.804	26.804	0.333	0.073	6.693	9.832	0.795	0.265	0.536	0.051	N60cs>25
347.2	57.5	36	5	0.073	4.185	24.055	24.055	0.274	0.073	6.876	10.171	0.790	0.216	0.516	0.050	4.320
344.7	60	37	5	0.073	4.368	24.054	24.054	0.274	0.073	7.059	10.510	0.786	0.215	0.495	0.048	4.479
342.2	62.5	31	5	0.071	4.548	19.632	19.632	0.211	0.071	7.239	10.846	0.782	0.165	0.475	0.046	3.587
339.7	65	42	5	0.074	4.729	25.922	25.922	0.311	0.074	7.420	11.183	0.778	0.242	0.455	0.045	N60cs>25
337.2	67.5	9	12	0.060	4.897	5.427	7.152	0.089	0.060	7.588	11.507	0.775	0.069	0.435	0.043	1.605
334.7	70	47	5	0.075	5.066	27.699	27.699	0.359	0.075	7.757	11.832	0.771	0.277	0.414	0.041	N60cs>25
332.2	72.5	17	5	0.066	5.242	9.788	9.788	0.111	0.066	7.933	12.164	0.768	0.085	0.394	0.039	2.179
329.7	75	100	5	0.083	5.428	56.208	56.208	1.000	0.083	8.119	12.506	0.764	0.764	0.374	0.037	N60cs>25
327.2	77.5	47	5	0.075	5.626	25.766	25.766	0.308	0.075	8.317	12.860	0.761	0.234	0.354	0.036	N60cs>25
324.7	80	17	5	0.066	5.802	9.120	9.120	0.105	0.066	8.493	13.192	0.758	0.080	0.333	0.034	2.353
322.2	82.5	7	5	0.058	5.957	3.686	3.686	0.063	0.058	8.648	13.503	0.755	0.048	0.313	0.032	1.500
319.7	85	37	5	0.073	6.121	19.388	19.388	0.208	0.073	8.812	13.823	0.752	0.156	0.293	0.030	5.200
317.2	87.5	22	5	0.068	6.297	11.528	11.528	0.127	0.068	8.988	14.155	0.749	0.095	0.273	0.028	3.393
314.7	90	25	5	0.069	6.468	13.100	13.100	0.141	0.069	9.159	14.482	0.746	0.105	0.252	0.026	4.038
312.2	92.5	36	5	0.073	6.646	18.864	18.864	0.202	0.073	9.337	14.816	0.743	0.150	0.232	0.024	6.250
309.7	95	100	5	0.083	6.841	52.400	52.400	1.000	0.083	9.532	15.167	0.740	0.740	0.212	0.022	N60cs>25
307.2	97.5	85	5	0.081	7.046	44.540	44.540	1.000	0.081	9.737	15.528	0.737	0.737	0.192	0.020	N60cs>25
304.7	100	79	5	0.080	7.247	41.396	41.396	1.000	0.080	9.938	15.885	0.734	0.734	0.171	0.018	N60cs>25
302.2	102.5	100	5	0.083	7.451	52.400	52.400	1.000	0.083	10.142	16.245	0.731	0.731	0.151	0.016	N60cs>25
299.7	105	100	5	0.083	7.659	52.400	52.400	1.000	0.083	10.350	16.609	0.728	0.728	0.131	0.014	N60cs>25

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-10 1000 Short period  
 ELEVATION OF BORING GROUND SURFACE ===== 404.70 FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 28.49 FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.190 Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 5.6 Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 23.79 FT. (Which is 2.8548 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<math>\alpha</math>)=</b> 1.00
Earthquake Magnitude Scaling Factor <b>(MSF)=</b> 2.112

Elev. of Sample (Feet)	Boring Data			Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K $\sigma$ )(K $\alpha$ )(MSF)				
402.2	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	3.269	3.269	1.937	<b>0.300</b>	0.940	<b>0.116</b>	<b>ABO. WAT.</b>
399.7	5	5	50	0.111	0.580	6.753	13.104	0.142	0.055	3.479	3.498	1.913	<b>0.272</b>	0.934	<b>0.116</b>	<b>NL</b>
397.2	7.5	4	50	0.109	0.855	4.996	10.995	0.122	0.054	3.615	3.790	1.898	<b>0.232</b>	0.921	<b>0.119</b>	<b>NL</b>
394.7	10	5	12	0.055	1.060	5.761	7.496	0.092	0.055	3.751	4.082	1.884	<b>0.173</b>	0.900	<b>0.121</b>	<b>1.430</b>
392.2	12.5	7	12	0.058	1.201	7.779	9.578	0.109	0.058	3.892	4.379	1.870	<b>0.204</b>	0.880	<b>0.122</b>	<b>1.672</b>
389.7	15	9	12	0.060	1.349	9.680	11.539	0.127	0.060	4.040	4.683	1.856	<b>0.236</b>	0.860	<b>0.123</b>	<b>1.919</b>
387.2	17.5	13	5	0.063	1.503	13.581	13.581	0.146	0.063	4.194	4.993	1.843	<b>0.269</b>	0.840	<b>0.124</b>	<b>2.169</b>
384.7	20	6	50	0.057	1.653	6.124	12.349	0.134	0.057	4.344	5.299	1.830	<b>0.245</b>	0.819	<b>0.123</b>	<b>NL</b>
382.2	22.5	11	5	0.062	1.802	11.010	11.010	0.122	0.062	4.493	5.604	1.817	<b>0.222</b>	0.799	<b>0.123</b>	<b>1.805</b>
379.7	25	25	5	0.069	1.966	24.518	24.518	0.283	0.069	4.657	5.924	1.804	<b>0.511</b>	0.779	<b>0.122</b>	<b>4.189</b>
377.2	27.5	27	5	0.070	2.140	25.961	25.961	0.312	0.070	4.831	6.254	1.791	<b>0.559</b>	0.759	<b>0.121</b>	<b>N60cs&gt;25</b>
374.7	30	13	5	0.063	2.306	12.105	12.105	0.132	0.063	4.997	6.576	1.779	<b>0.235</b>	0.738	<b>0.120</b>	<b>1.958</b>
372.2	32.5	23	5	0.068	2.470	20.693	20.693	0.224	0.068	5.161	6.896	1.768	<b>0.396</b>	0.718	<b>0.118</b>	<b>3.356</b>
369.7	35	23	5	0.068	2.640	20.016	20.016	0.216	0.068	5.331	7.222	1.756	<b>0.379</b>	0.698	<b>0.117</b>	<b>3.239</b>
367.2	37.5	17	5	0.066	2.808	14.345	14.345	0.154	0.066	5.499	7.546	1.745	<b>0.269</b>	0.678	<b>0.115</b>	<b>2.339</b>
364.7	40	19	5	0.067	2.974	15.579	15.579	0.166	0.067	5.665	7.868	1.735	<b>0.288</b>	0.657	<b>0.113</b>	<b>2.549</b>
362.2	42.5	17	5	0.066	3.140	13.565	13.565	0.146	0.066	5.831	8.190	1.725	<b>0.252</b>	0.637	<b>0.110</b>	<b>2.291</b>
359.7	45	16	5	0.065	3.304	12.447	12.447	0.135	0.065	5.995	8.510	1.716	<b>0.232</b>	0.617	<b>0.108</b>	<b>2.148</b>
357.2	47.5	18	5	0.066	3.468	13.667	13.667	0.147	0.066	6.159	8.830	1.706	<b>0.251</b>	0.597	<b>0.106</b>	<b>2.368</b>
354.7	50	27	5	0.070	3.638	20.016	20.016	0.216	0.070	6.329	9.156	1.697	<b>0.367</b>	0.576	<b>0.103</b>	<b>3.563</b>
352.2	52.5	41	5	0.074	3.818	29.670	29.670	0.446	0.074	6.509	9.492	1.688	<b>0.753</b>	0.556	<b>0.100</b>	<b>N60cs&gt;25</b>
349.7	55	39	5	0.073	4.002	26.804	26.804	0.333	0.073	6.693	9.832	1.678	<b>0.559</b>	0.536	<b>0.097</b>	<b>N60cs&gt;25</b>
347.2	57.5	36	5	0.073	4.185	24.055	24.055	0.274	0.073	6.876	10.171	1.669	<b>0.457</b>	0.516	<b>0.094</b>	<b>4.862</b>
344.7	60	37	5	0.073	4.368	24.054	24.054	0.274	0.073	7.059	10.510	1.660	<b>0.455</b>	0.495	<b>0.091</b>	<b>5.000</b>
342.2	62.5	31	5	0.071	4.548	19.632	19.632	0.211	0.071	7.239	10.846	1.652	<b>0.349</b>	0.475	<b>0.088</b>	<b>3.966</b>
339.7	65	42	5	0.074	4.729	25.922	25.922	0.311	0.074	7.420	11.183	1.644	<b>0.511</b>	0.455	<b>0.085</b>	<b>N60cs&gt;25</b>
337.2	67.5	9	12	0.060	4.897	5.427	7.152	0.089	0.060	7.588	11.507	1.637	<b>0.146</b>	0.435	<b>0.081</b>	<b>1.802</b>
334.7	70	47	5	0.075	5.066	27.699	27.699	0.359	0.075	7.757	11.832	1.629	<b>0.585</b>	0.414	<b>0.078</b>	<b>N60cs&gt;25</b>
332.2	72.5	17	5	0.066	5.242	9.788	9.788	0.111	0.066	7.933	12.164	1.622	<b>0.180</b>	0.394	<b>0.075</b>	<b>2.400</b>
329.7	75	100	5	0.083	5.428	56.208	56.208	1.000	0.083	8.119	12.506	1.615	<b>1.615</b>	0.374	<b>0.071</b>	<b>N60cs&gt;25</b>
327.2	77.5	47	5	0.075	5.626	25.766	25.766	0.308	0.075	8.317	12.860	1.607	<b>0.495</b>	0.354	<b>0.068</b>	<b>N60cs&gt;25</b>
324.7	80	17	5	0.066	5.802	9.120	9.120	0.105	0.066	8.493	13.192	1.600	<b>0.168</b>	0.333	<b>0.064</b>	<b>2.625</b>
322.2	82.5	7	5	0.058	5.957	3.686	3.686	0.063	0.058	8.648	13.503	1.594	<b>0.100</b>	0.313	<b>0.060</b>	<b>1.667</b>
319.7	85	37	5	0.073	6.121	19.388	19.388	0.208	0.073	8.812	13.823	1.588	<b>0.330</b>	0.293	<b>0.057</b>	<b>5.789</b>
317.2	87.5	22	5	0.068	6.297	11.528	11.528	0.127	0.068	8.988	14.155	1.582	<b>0.201</b>	0.273	<b>0.053</b>	<b>3.792</b>
314.7	90	25	5	0.069	6.468	13.100	13.100	0.141	0.069	9.159	14.482	1.576	<b>0.222</b>	0.252	<b>0.049</b>	<b>4.531</b>
312.2	92.5	36	5	0.073	6.646	18.864	18.864	0.202	0.073	9.337	14.816	1.570	<b>0.317</b>	0.232	<b>0.045</b>	<b>7.044</b>
309.7	95	100	5	0.083	6.841	52.400	52.400	1.000	0.083	9.532	15.167	1.564	<b>1.564</b>	0.212	<b>0.042</b>	<b>N60cs&gt;25</b>
307.2	97.5	85	5	0.081	7.046	44.540	44.540	1.000	0.081	9.737	15.528	1.557	<b>1.557</b>	0.192	<b>0.038</b>	<b>N60cs&gt;25</b>
304.7	100	79	5	0.080	7.247	41.396	41.396	1.000	0.080	9.938	15.885	1.551	<b>1.551</b>	0.171	<b>0.034</b>	<b>N60cs&gt;25</b>
302.2	102.5	100	5	0.083	7.451	52.400	52.400	1.000	0.083	10.142	16.245	1.544	<b>1.544</b>	0.151	<b>0.030</b>	<b>N60cs&gt;25</b>
299.7	105	100	5	0.083	7.659	52.400	52.400	1.000	0.083	10.350	16.609	1.538	<b>1.538</b>	0.131	<b>0.026</b>	<b>N60cs&gt;25</b>

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-10** **2500 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **404.70** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **28.49** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.120** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.7** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **23.79** FT. (Which is 2.8548 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor	<b>(K<sub>α</sub>)= 1.00</b>
Earthquake Magnitude Scaling Factor	<b>(MSF)= 0.935</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)		Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> )60	Fines Content Corrected (N <sub>1</sub> )60cs	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)				
402.2	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	3.269	3.269	0.857	0.133	0.940	0.073	ABO. WAT.	
399.7	5	5	50	0.111	0.580	6.753	13.104	0.142	0.055	3.479	3.498	0.847	0.120	0.934	0.073	NL	
397.2	7.5	4	50	0.109	0.855	4.996	10.995	0.122	0.054	3.615	3.790	0.840	0.102	0.921	0.075	NL	
394.7	10	5	12	0.055	1.060	5.761	7.496	0.092	0.055	3.751	4.082	0.834	0.077	0.900	0.076	1.013	
392.2	12.5	7	12	0.058	1.201	7.779	9.578	0.109	0.058	3.892	4.379	0.828	0.090	0.880	0.077	1.169	
389.7	15	9	12	0.060	1.349	9.680	11.539	0.127	0.060	4.040	4.683	0.822	0.104	0.860	0.078	1.333	
387.2	17.5	13	5	0.063	1.503	13.581	13.581	0.146	0.063	4.194	4.993	0.816	0.119	0.840	0.078	1.526	
384.7	20	6	50	0.057	1.653	6.124	12.349	0.134	0.057	4.344	5.299	0.810	0.109	0.819	0.078	NL	
382.2	22.5	11	5	0.062	1.802	11.010	11.010	0.122	0.062	4.493	5.604	0.805	0.098	0.799	0.078	1.256	
379.7	25	25	5	0.069	1.966	24.518	24.518	0.283	0.069	4.657	5.924	0.799	0.226	0.779	0.077	2.935	
377.2	27.5	27	5	0.070	2.140	25.961	25.961	0.312	0.070	4.831	6.254	0.793	0.247	0.759	0.077	N60cs>25	
374.7	30	13	5	0.063	2.306	12.105	12.105	0.132	0.063	4.997	6.576	0.788	0.104	0.738	0.076	1.368	
372.2	32.5	23	5	0.068	2.470	20.693	20.693	0.224	0.068	5.161	6.896	0.783	0.175	0.718	0.075	2.333	
369.7	35	23	5	0.068	2.640	20.016	20.016	0.216	0.068	5.331	7.222	0.778	0.168	0.698	0.074	2.270	
367.2	37.5	17	5	0.066	2.808	14.345	14.345	0.154	0.066	5.499	7.546	0.773	0.119	0.678	0.073	1.630	
364.7	40	19	5	0.067	2.974	15.579	15.579	0.166	0.067	5.665	7.868	0.768	0.127	0.657	0.071	1.789	
362.2	42.5	17	5	0.066	3.140	13.565	13.565	0.146	0.066	5.831	8.190	0.764	0.112	0.637	0.070	1.600	
359.7	45	16	5	0.065	3.304	12.447	12.447	0.135	0.065	5.995	8.510	0.759	0.102	0.617	0.068	1.500	
357.2	47.5	18	5	0.066	3.468	13.667	13.667	0.147	0.066	6.159	8.830	0.755	0.111	0.597	0.067	1.657	
354.7	50	27	5	0.070	3.638	20.016	20.016	0.216	0.070	6.329	9.156	0.751	0.162	0.576	0.065	2.492	
352.2	52.5	41	5	0.074	3.818	29.670	29.670	0.446	0.074	6.509	9.492	0.747	0.333	0.556	0.063	N60cs>25	
349.7	55	39	5	0.073	4.002	26.804	26.804	0.333	0.073	6.693	9.832	0.743	0.247	0.536	0.061	N60cs>25	
347.2	57.5	36	5	0.073	4.185	24.055	24.055	0.274	0.073	6.876	10.171	0.739	0.202	0.516	0.060	3.367	
344.7	60	37	5	0.073	4.368	24.054	24.054	0.274	0.073	7.059	10.510	0.735	0.201	0.495	0.057	3.526	
342.2	62.5	31	5	0.071	4.548	19.632	19.632	0.211	0.071	7.239	10.846	0.731	0.154	0.475	0.056	2.750	
339.7	65	42	5	0.074	4.729	25.922	25.922	0.311	0.074	7.420	11.183	0.728	0.226	0.455	0.053	N60cs>25	
337.2	67.5	9	12	0.060	4.897	5.427	7.152	0.089	0.060	7.588	11.507	0.725	0.065	0.435	0.051	1.275	
334.7	70	47	5	0.075	5.066	27.699	27.699	0.359	0.075	7.757	11.832	0.721	0.259	0.414	0.049	N60cs>25	
332.2	72.5	17	5	0.066	5.242	9.788	9.788	0.111	0.066	7.933	12.164	0.718	0.080	0.394	0.047	1.702	
329.7	75	100	5	0.083	5.428	56.208	56.208	1.000	0.083	8.119	12.506	0.715	0.715	0.374	0.045	N60cs>25	
327.2	77.5	47	5	0.075	5.626	25.766	25.766	0.308	0.075	8.317	12.860	0.711	0.219	0.354	0.043	N60cs>25	
324.7	80	17	5	0.066	5.802	9.120	9.120	0.105	0.066	8.493	13.192	0.708	0.074	0.333	0.040	1.850	
322.2	82.5	7	5	0.058	5.957	3.686	3.686	0.063	0.058	8.648	13.503	0.706	0.044	0.313	0.038	1.158	
319.7	85	37	5	0.073	6.121	19.388	19.388	0.208	0.073	8.812	13.823	0.703	0.146	0.293	0.036	4.056	
317.2	87.5	22	5	0.068	6.297	11.528	11.528	0.127	0.068	8.988	14.155	0.700	0.089	0.273	0.034	2.618	
314.7	90	25	5	0.069	6.468	13.100	13.100	0.141	0.069	9.159	14.482	0.698	0.098	0.252	0.031	3.161	
312.2	92.5	36	5	0.073	6.646	18.864	18.864	0.202	0.073	9.337	14.816	0.695	0.140	0.232	0.029	4.828	
309.7	95	100	5	0.083	6.841	52.400	52.400	1.000	0.083	9.532	15.167	0.692	0.692	0.212	0.026	N60cs>25	
307.2	97.5	85	5	0.081	7.046	44.540	44.540	1.000	0.081	9.737	15.528	0.689	0.689	0.192	0.024	N60cs>25	
304.7	100	79	5	0.080	7.247	41.396	41.396	1.000	0.080	9.938	15.885	0.686	0.686	0.171	0.021	N60cs>25	
302.2	102.5	100	5	0.083	7.451	52.400	52.400	1.000	0.083	10.142	16.245	0.684	0.684	0.151	0.019	N60cs>25	
299.7	105	100	5	0.083	7.659	52.400	52.400	1.000	0.083	10.350	16.609	0.681	0.681	0.131	0.016	N60cs>25	

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-10 2500 Short period  
ELEVATION OF BORING GROUND SURFACE ===== 404.70 FT.  
DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 28.49 FT. (Below Finished Grade Cut or Fill Surface)  
MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.260 Coefficient of Gravity  
DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 6.0 Moment Magnitude Scale  
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 23.79 FT. (Which is 2.8548 ksf Effect. Surch. Fill Press.)  
ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor	(K <sub>α</sub> )= 1.00
Earthquake Magnitude Scaling Factor	(MSF)= 1.770

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR 7.5 Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)	%	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> )60	Fines Content Corrected (N <sub>1</sub> )60cs	CRR Resisting Mag 7.5 CRR 7.5	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)				
402.2	2.5	6	50	0.113	0.300	7.877	14.452	0.155	0.113	3.269	3.269	1.623	0.252	0.940	0.159	ABO. WAT.
399.7	5	5	50	0.111	0.580	6.753	13.104	0.142	0.055	3.479	3.498	1.603	0.228	0.934	0.159	NL
397.2	7.5	4	50	0.109	0.855	4.996	10.995	0.122	0.054	3.615	3.790	1.591	0.194	0.921	0.163	NL
394.7	10	5	12	0.055	1.060	5.761	7.496	0.092	0.055	3.751	4.082	1.579	0.145	0.900	0.166	0.873
392.2	12.5	7	12	0.058	1.201	7.779	9.578	0.109	0.058	3.892	4.379	1.567	0.171	0.880	0.167	1.024
389.7	15	9	12	0.060	1.349	9.680	11.539	0.127	0.060	4.040	4.683	1.556	0.198	0.860	0.168	1.179
387.2	17.5	13	5	0.063	1.503	13.581	13.581	0.146	0.063	4.194	4.993	1.544	0.225	0.840	0.169	1.331
384.7	20	6	50	0.057	1.653	6.124	12.349	0.134	0.057	4.344	5.299	1.533	0.205	0.819	0.169	NL
382.2	22.5	11	5	0.062	1.802	11.010	11.010	0.122	0.062	4.493	5.604	1.523	0.186	0.799	0.168	1.107
379.7	25	25	5	0.069	1.966	24.518	24.518	0.283	0.069	4.657	5.924	1.512	0.428	0.779	0.167	2.563
377.2	27.5	27	5	0.070	2.140	25.961	25.961	0.312	0.070	4.831	6.254	1.501	0.468	0.759	0.166	N60cs>25
374.7	30	13	5	0.063	2.306	12.105	12.105	0.132	0.063	4.997	6.576	1.491	0.197	0.738	0.164	1.201
372.2	32.5	23	5	0.068	2.470	20.693	20.693	0.224	0.068	5.161	6.896	1.481	0.332	0.718	0.162	2.049
369.7	35	23	5	0.068	2.640	20.016	20.016	0.216	0.068	5.331	7.222	1.472	0.318	0.698	0.160	1.988
367.2	37.5	17	5	0.066	2.808	14.345	14.345	0.154	0.066	5.499	7.546	1.463	0.225	0.678	0.157	1.433
364.7	40	19	5	0.067	2.974	15.579	15.579	0.166	0.067	5.665	7.868	1.454	0.241	0.657	0.154	1.565
362.2	42.5	17	5	0.066	3.140	13.565	13.565	0.146	0.066	5.831	8.190	1.446	0.211	0.637	0.151	1.397
359.7	45	16	5	0.065	3.304	12.447	12.447	0.135	0.065	5.995	8.510	1.438	0.194	0.617	0.148	1.311
357.2	47.5	18	5	0.066	3.468	13.667	13.667	0.147	0.066	6.159	8.830	1.430	0.210	0.597	0.145	1.448
354.7	50	27	5	0.070	3.638	20.016	20.016	0.216	0.070	6.329	9.156	1.422	0.307	0.576	0.141	2.177
352.2	52.5	41	5	0.074	3.818	29.670	29.670	0.446	0.074	6.509	9.492	1.414	0.631	0.556	0.137	N60cs>25
349.7	55	39	5	0.073	4.002	26.804	26.804	0.333	0.073	6.693	9.832	1.406	0.468	0.536	0.133	N60cs>25
347.2	57.5	36	5	0.073	4.185	24.055	24.055	0.274	0.073	6.876	10.171	1.399	0.383	0.516	0.129	2.969
344.7	60	37	5	0.073	4.368	24.054	24.054	0.274	0.073	7.059	10.510	1.392	0.381	0.495	0.125	3.048
342.2	62.5	31	5	0.071	4.548	19.632	19.632	0.211	0.071	7.239	10.846	1.385	0.292	0.475	0.120	2.433
339.7	65	42	5	0.074	4.729	25.922	25.922	0.311	0.074	7.420	11.183	1.378	0.429	0.455	0.116	N60cs>25
337.2	67.5	9	12	0.060	4.897	5.427	7.152	0.089	0.060	7.588	11.507	1.372	0.122	0.435	0.111	1.099
334.7	70	47	5	0.075	5.066	27.699	27.699	0.359	0.075	7.757	11.832	1.366	0.490	0.414	0.107	N60cs>25
332.2	72.5	17	5	0.066	5.242	9.788	9.788	0.111	0.066	7.933	12.164	1.359	0.151	0.394	0.102	1.480
329.7	75	100	5	0.083	5.428	56.208	56.208	1.000	0.083	8.119	12.506	1.353	1.353	0.374	0.097	N60cs>25
327.2	77.5	47	5	0.075	5.626	25.766	25.766	0.308	0.075	8.317	12.860	1.347	0.415	0.354	0.093	N60cs>25
324.7	80	17	5	0.066	5.802	9.120	9.120	0.105	0.066	8.493	13.192	1.341	0.141	0.333	0.087	1.621
322.2	82.5	7	5	0.058	5.957	3.686	3.686	0.063	0.058	8.648	13.503	1.336	0.084	0.313	0.083	1.012
319.7	85	37	5	0.073	6.121	19.388	19.388	0.208	0.073	8.812	13.823	1.331	0.277	0.293	0.078	3.551
317.2	87.5	22	5	0.068	6.297	11.528	11.528	0.127	0.068	8.988	14.155	1.326	0.168	0.273	0.073	2.301
314.7	90	25	5	0.069	6.468	13.100	13.100	0.141	0.069	9.159	14.482	1.321	0.186	0.252	0.067	2.776
312.2	92.5	36	5	0.073	6.646	18.864	18.864	0.202	0.073	9.337	14.816	1.316	0.266	0.232	0.062	4.290
309.7	95	100	5	0.083	6.841	52.400	52.400	1.000	0.083	9.532	15.167	1.310	1.310	0.212	0.057	N60cs>25
307.2	97.5	85	5	0.081	7.046	44.540	44.540	1.000	0.081	9.737	15.528	1.305	1.305	0.192	0.052	N60cs>25
304.7	100	79	5	0.080	7.247	41.396	41.396	1.000	0.080	9.938	15.885	1.300	1.300	0.171	0.046	N60cs>25
302.2	102.5	100	5	0.083	7.451	52.400	52.400	1.000	0.083	10.142	16.245	1.294	1.294	0.151	0.041	N60cs>25
299.7	105	100	5	0.083	7.659	52.400	52.400	1.000	0.083	10.350	16.609	1.289	1.289	0.131	0.036	N60cs>25

\*ABO. WAT. = ABOVE WATER TABLE  
\*NL = NOT LIQUEFIABLE  
\*ABO. GRA. = ABOVE FINISHED GRADE  
\*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
\*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-11 1000 Long period  
 ELEVATION OF BORING GROUND SURFACE ===== 405.40 FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 26.24 FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.100 Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 7.5 Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 20.84 FT. (Which is 2.5008 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor	<b>(K<math>\alpha</math>)= 1.00</b>
Earthquake Magnitude Scaling Factor	<b>(MSF)= 1.000</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K $\sigma$ )(K $\alpha$ )(MSF)				
402.9	2.5	4	50	0.109	0.300	5.251	11.301	0.125	0.109	2.952	2.952	0.936	0.117	0.946	0.061	ABO. WAT.
400.4	5	6	50	0.113	0.578	8.104	14.725	0.157	0.113	3.230	3.230	0.919	0.144	0.941	0.061	ABO. WAT.
397.9	7.5	4	50	0.109	0.856	4.993	10.992	0.122	0.054	3.439	3.570	0.908	0.111	0.935	0.063	NL
395.4	10	4	50	0.054	1.060	4.609	10.531	0.118	0.054	3.574	3.861	0.901	0.106	0.924	0.065	NL
392.9	12.5	8	12	0.059	1.201	8.890	10.724	0.120	0.059	3.715	4.158	0.894	0.107	0.904	0.066	1.621
390.4	15	7	12	0.058	1.347	7.535	9.326	0.107	0.058	3.861	4.460	0.887	0.095	0.884	0.066	1.439
387.9	17.5	11	12	0.062	1.497	11.514	13.431	0.145	0.062	4.011	4.766	0.880	0.128	0.863	0.067	1.910
385.4	20	5	40	0.055	1.643	5.119	11.143	0.123	0.055	4.157	5.068	0.874	0.108	0.843	0.067	1.612
382.9	22.5	20	50	0.067	1.796	20.052	29.062	0.413	0.067	4.310	5.377	0.868	0.358	0.823	0.067	N60cs>25
380.4	25	23	6	0.068	1.965	22.562	22.698	0.252	0.068	4.479	5.702	0.861	0.217	0.803	0.066	3.288
377.9	27.5	11	6	0.062	2.128	10.606	10.685	0.119	0.062	4.642	6.021	0.855	0.102	0.782	0.066	1.545
375.4	30	15	6	0.065	2.287	14.025	14.121	0.151	0.065	4.801	6.336	0.849	0.128	0.762	0.065	1.969
372.9	32.5	15	6	0.065	2.450	13.551	13.644	0.147	0.065	4.964	6.655	0.844	0.124	0.742	0.065	1.908
370.4	35	21	6	0.068	2.616	18.359	18.475	0.197	0.068	5.130	6.977	0.838	0.165	0.722	0.064	2.578
367.9	37.5	28	6	0.070	2.789	23.707	23.848	0.271	0.070	5.303	7.306	0.832	0.225	0.701	0.063	3.571
365.4	40	22	6	0.068	2.962	18.075	18.190	0.194	0.068	5.476	7.635	0.827	0.160	0.681	0.062	2.581
362.9	42.5	26	6	0.070	3.135	20.764	20.891	0.227	0.070	5.649	7.964	0.822	0.187	0.661	0.061	3.066
360.4	45	24	6	0.069	3.309	18.656	18.773	0.201	0.069	5.823	8.294	0.817	0.164	0.641	0.059	2.780
357.9	47.5	24	6	0.069	3.482	18.186	18.301	0.195	0.069	5.996	8.623	0.812	0.158	0.620	0.058	2.724
355.4	50	11	6	0.062	3.646	8.146	8.214	0.098	0.062	6.160	8.943	0.808	0.079	0.600	0.057	1.386
352.9	52.5	11	6	0.062	3.801	7.978	8.045	0.096	0.062	6.315	9.254	0.804	0.077	0.580	0.055	1.400
350.4	55	16	6	0.065	3.960	11.369	11.452	0.126	0.065	6.474	9.569	0.800	0.101	0.560	0.054	1.870
347.9	57.5	32	6	0.071	4.130	21.562	21.693	0.238	0.071	6.644	9.895	0.796	0.189	0.539	0.052	3.635
345.4	60	25	6	0.069	4.305	16.406	16.513	0.176	0.069	6.819	10.226	0.792	0.139	0.519	0.051	2.725
342.9	62.5	36	6	0.073	4.483	23.013	23.151	0.259	0.073	6.997	10.560	0.788	0.204	0.499	0.049	4.163
340.4	65	34	6	0.072	4.664	21.178	21.307	0.232	0.072	7.178	10.897	0.784	0.182	0.479	0.047	3.872
337.9	67.5	28	12	0.070	4.842	17.012	19.103	0.205	0.070	7.356	11.231	0.780	0.160	0.458	0.045	3.556
335.4	70	25	12	0.069	5.016	14.833	16.855	0.179	0.069	7.530	11.561	0.776	0.139	0.438	0.044	3.159
332.9	72.5	83	12	0.081	5.204	48.027	51.097	1.000	0.081	7.718	11.905	0.772	0.772	0.418	0.042	N60cs>25
330.4	75	40	12	0.074	5.398	22.570	24.836	0.289	0.074	7.912	12.255	0.768	0.222	0.398	0.040	5.550
327.9	77.5	21	12	0.068	5.576	11.585	13.504	0.145	0.068	8.090	12.589	0.765	0.111	0.377	0.038	2.921
325.4	80	13	6	0.063	5.740	7.027	7.090	0.088	0.063	8.254	12.909	0.762	0.067	0.357	0.036	1.861

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction



# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-11 1000 Short period  
 ELEVATION OF BORING GROUND SURFACE ===== 405.40 FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 26.24 FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.190 Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 5.6 Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 20.84 FT. (Which is 2.5008 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<math>\alpha</math>)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 2.112</b>

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K $\sigma$ )(K $\alpha$ )(MSF)				
402.9	2.5	4	50	0.109	0.300	5.251	11.301	0.125	0.109	2.952	2.952	1.977	0.247	0.946	0.117	ABO. WAT.
400.4	5	6	50	0.113	0.578	8.104	14.725	0.157	0.113	3.230	3.230	1.941	0.305	0.941	0.116	ABO. WAT.
397.9	7.5	4	50	0.109	0.856	4.993	10.992	0.122	0.054	3.439	3.570	1.917	0.234	0.935	0.120	NL
395.4	10	4	50	0.054	1.060	4.609	10.531	0.118	0.054	3.574	3.861	1.903	0.225	0.924	0.123	NL
392.9	12.5	8	12	0.059	1.201	8.890	10.724	0.120	0.059	3.715	4.158	1.888	0.227	0.904	0.125	1.816
390.4	15	7	12	0.058	1.347	7.535	9.326	0.107	0.058	3.861	4.460	1.873	0.200	0.884	0.126	1.587
387.9	17.5	11	12	0.062	1.497	11.514	13.431	0.145	0.062	4.011	4.766	1.859	0.270	0.863	0.127	2.126
385.4	20	5	40	0.055	1.643	5.119	11.143	0.123	0.055	4.157	5.068	1.846	0.227	0.843	0.127	1.787
382.9	22.5	20	50	0.067	1.796	20.052	29.062	0.413	0.067	4.310	5.377	1.833	0.757	0.823	0.127	N60cs>25
380.4	25	23	6	0.068	1.965	22.562	22.698	0.252	0.068	4.479	5.702	1.819	0.458	0.803	0.126	3.635
377.9	27.5	11	6	0.062	2.128	10.606	10.685	0.119	0.062	4.642	6.021	1.806	0.215	0.782	0.125	1.720
375.4	30	15	6	0.065	2.287	14.025	14.121	0.151	0.065	4.801	6.336	1.793	0.271	0.762	0.124	2.185
372.9	32.5	15	6	0.065	2.450	13.551	13.644	0.147	0.065	4.964	6.655	1.782	0.262	0.742	0.123	2.130
370.4	35	21	6	0.068	2.616	18.359	18.475	0.197	0.068	5.130	6.977	1.770	0.349	0.722	0.121	2.884
367.9	37.5	28	6	0.070	2.789	23.707	23.848	0.271	0.070	5.303	7.306	1.758	0.476	0.701	0.119	4.000
365.4	40	22	6	0.068	2.962	18.075	18.190	0.194	0.068	5.476	7.635	1.747	0.339	0.681	0.117	2.897
362.9	42.5	26	6	0.070	3.135	20.764	20.891	0.227	0.070	5.649	7.964	1.736	0.394	0.661	0.115	3.426
360.4	45	24	6	0.069	3.309	18.656	18.773	0.201	0.069	5.823	8.294	1.726	0.347	0.641	0.113	3.071
357.9	47.5	24	6	0.069	3.482	18.186	18.301	0.195	0.069	5.996	8.623	1.715	0.334	0.620	0.110	3.036
355.4	50	11	6	0.062	3.646	8.146	8.214	0.098	0.062	6.160	8.943	1.706	0.167	0.600	0.108	1.546
352.9	52.5	11	6	0.062	3.801	7.978	8.045	0.096	0.062	6.315	9.254	1.698	0.163	0.580	0.105	1.552
350.4	55	16	6	0.065	3.960	11.369	11.452	0.126	0.065	6.474	9.569	1.689	0.213	0.560	0.102	2.088
347.9	57.5	32	6	0.071	4.130	21.562	21.693	0.238	0.071	6.644	9.895	1.681	0.400	0.539	0.099	4.040
345.4	60	25	6	0.069	4.305	16.406	16.513	0.176	0.069	6.819	10.226	1.672	0.294	0.519	0.096	3.063
342.9	62.5	36	6	0.073	4.483	23.013	23.151	0.259	0.073	6.997	10.560	1.663	0.431	0.499	0.093	4.634
340.4	65	34	6	0.072	4.664	21.178	21.307	0.232	0.072	7.178	10.897	1.655	0.384	0.479	0.090	4.267
337.9	67.5	28	12	0.070	4.842	17.012	19.103	0.205	0.070	7.356	11.231	1.647	0.338	0.458	0.086	3.930
335.4	70	25	12	0.069	5.016	14.833	16.855	0.179	0.069	7.530	11.561	1.639	0.293	0.438	0.083	3.530
332.9	72.5	83	12	0.081	5.204	48.027	51.097	1.000	0.081	7.718	11.905	1.631	1.631	0.418	0.080	N60cs>25
330.4	75	40	12	0.074	5.398	22.570	24.836	0.289	0.074	7.912	12.255	1.623	0.469	0.398	0.076	6.171
327.9	77.5	21	12	0.068	5.576	11.585	13.504	0.145	0.068	8.090	12.589	1.616	0.234	0.377	0.072	3.250
325.4	80	13	6	0.063	5.740	7.027	7.090	0.088	0.063	8.254	12.909	1.609	0.142	0.357	0.069	2.058

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-11** **2500 Long period**  
 ELEVATION OF BORING GROUND SURFACE ===== **405.40** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **26.24** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.120** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **7.7** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **20.84** FT. (Which is 2.5008 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(K<sub>α</sub>)=</b> 1.00
Earthquake Magnitude Scaling Factor <b>(MSF)=</b> 0.935

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> )60	Fines Content Corrected (N <sub>1</sub> )60cs	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K <sub>σ</sub> )(K <sub>α</sub> )(MSF)					
402.9	2.5	4	50	0.109	0.300	5.251	11.301	0.125	0.109	2.952	2.952	0.875	<b>0.109</b>	0.946	<b>0.074</b>	<b>ABO. WAT.</b>	
400.4	5	6	50	0.113	0.578	8.104	14.725	0.157	0.113	3.230	3.230	0.859	<b>0.135</b>	0.941	<b>0.073</b>	<b>ABO. WAT.</b>	
397.9	7.5	4	50	0.109	0.856	4.993	10.992	0.122	0.054	3.439	3.570	0.849	<b>0.104</b>	0.935	<b>0.076</b>	<b>NL</b>	
395.4	10	4	50	0.054	1.060	4.609	10.531	0.118	0.054	3.574	3.861	0.842	<b>0.099</b>	0.924	<b>0.078</b>	<b>NL</b>	
392.9	12.5	8	12	0.059	1.201	8.890	10.724	0.120	0.059	3.715	4.158	0.836	<b>0.100</b>	0.904	<b>0.079</b>	<b>1.266</b>	
390.4	15	7	12	0.058	1.347	7.535	9.326	0.107	0.058	3.861	4.460	0.829	<b>0.089</b>	0.884	<b>0.080</b>	<b>1.113</b>	
387.9	17.5	11	12	0.062	1.497	11.514	13.431	0.145	0.062	4.011	4.766	0.823	<b>0.119</b>	0.863	<b>0.080</b>	<b>1.488</b>	
385.4	20	5	40	0.055	1.643	5.119	11.143	0.123	0.055	4.157	5.068	0.817	<b>0.100</b>	0.843	<b>0.080</b>	<b>1.250</b>	
382.9	22.5	20	50	0.067	1.796	20.052	29.062	0.413	0.067	4.310	5.377	0.811	<b>0.335</b>	0.823	<b>0.080</b>	<b>N60cs&gt;25</b>	
380.4	25	23	6	0.068	1.965	22.562	22.698	0.252	0.068	4.479	5.702	0.805	<b>0.203</b>	0.803	<b>0.080</b>	<b>2.538</b>	
377.9	27.5	11	6	0.062	2.128	10.606	10.685	0.119	0.062	4.642	6.021	0.799	<b>0.095</b>	0.782	<b>0.079</b>	<b>1.203</b>	
375.4	30	15	6	0.065	2.287	14.025	14.121	0.151	0.065	4.801	6.336	0.794	<b>0.120</b>	0.762	<b>0.078</b>	<b>1.538</b>	
372.9	32.5	15	6	0.065	2.450	13.551	13.644	0.147	0.065	4.964	6.655	0.789	<b>0.116</b>	0.742	<b>0.078</b>	<b>1.487</b>	
370.4	35	21	6	0.068	2.616	18.359	18.475	0.197	0.068	5.130	6.977	0.784	<b>0.154</b>	0.722	<b>0.077</b>	<b>2.000</b>	
367.9	37.5	28	6	0.070	2.789	23.707	23.848	0.271	0.070	5.303	7.306	0.778	<b>0.211</b>	0.701	<b>0.075</b>	<b>2.813</b>	
365.4	40	22	6	0.068	2.962	18.075	18.190	0.194	0.068	5.476	7.635	0.773	<b>0.150</b>	0.681	<b>0.074</b>	<b>2.027</b>	
362.9	42.5	26	6	0.070	3.135	20.764	20.891	0.227	0.070	5.649	7.964	0.769	<b>0.175</b>	0.661	<b>0.073</b>	<b>2.397</b>	
360.4	45	24	6	0.069	3.309	18.656	18.773	0.201	0.069	5.823	8.294	0.764	<b>0.154</b>	0.641	<b>0.071</b>	<b>2.169</b>	
357.9	47.5	24	6	0.069	3.482	18.186	18.301	0.195	0.069	5.996	8.623	0.759	<b>0.148</b>	0.620	<b>0.070</b>	<b>2.114</b>	
355.4	50	11	6	0.062	3.646	8.146	8.214	0.098	0.062	6.160	8.943	0.755	<b>0.074</b>	0.600	<b>0.068</b>	<b>1.088</b>	
352.9	52.5	11	6	0.062	3.801	7.978	8.045	0.096	0.062	6.315	9.254	0.752	<b>0.072</b>	0.580	<b>0.066</b>	<b>1.091</b>	
350.4	55	16	6	0.065	3.960	11.369	11.452	0.126	0.065	6.474	9.569	0.748	<b>0.094</b>	0.560	<b>0.065</b>	<b>1.446</b>	
347.9	57.5	32	6	0.071	4.130	21.562	21.693	0.238	0.071	6.644	9.895	0.744	<b>0.177</b>	0.539	<b>0.063</b>	<b>2.810</b>	
345.4	60	25	6	0.069	4.305	16.406	16.513	0.176	0.069	6.819	10.226	0.740	<b>0.130</b>	0.519	<b>0.061</b>	<b>2.131</b>	
342.9	62.5	36	6	0.073	4.483	23.013	23.151	0.259	0.073	6.997	10.560	0.736	<b>0.191</b>	0.499	<b>0.059</b>	<b>3.237</b>	
340.4	65	34	6	0.072	4.664	21.178	21.307	0.232	0.072	7.178	10.897	0.733	<b>0.170</b>	0.479	<b>0.057</b>	<b>2.982</b>	
337.9	67.5	28	12	0.070	4.842	17.012	19.103	0.205	0.070	7.356	11.231	0.729	<b>0.149</b>	0.458	<b>0.055</b>	<b>2.709</b>	
335.4	70	25	12	0.069	5.016	14.833	16.855	0.179	0.069	7.530	11.561	0.726	<b>0.130</b>	0.438	<b>0.052</b>	<b>2.500</b>	
332.9	72.5	83	12	0.081	5.204	48.027	51.097	1.000	0.081	7.718	11.905	0.722	<b>0.722</b>	0.418	<b>0.050</b>	<b>N60cs&gt;25</b>	
330.4	75	40	12	0.074	5.398	22.570	24.836	0.289	0.074	7.912	12.255	0.718	<b>0.208</b>	0.398	<b>0.048</b>	<b>4.333</b>	
327.9	77.5	21	12	0.068	5.576	11.585	13.504	0.145	0.068	8.090	12.589	0.715	<b>0.104</b>	0.377	<b>0.046</b>	<b>2.261</b>	
325.4	80	13	6	0.063	5.740	7.027	7.090	0.088	0.063	8.254	12.909	0.712	<b>0.063</b>	0.357	<b>0.044</b>	<b>1.432</b>	

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA. = ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-11 2500 Short period  
 ELEVATION OF BORING GROUND SURFACE ===== 405.40 FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 26.24 FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.260 Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 6.0 Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 20.84 FT. (Which is 2.5008 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground	
Shear Stress	
Correct. Factor	(K $\alpha$ )= 1.00
Earthquake	
Magnitude	
Scaling Factor	(MSF)= 1.770

Elev. of Sample (Feet)	Boring Data				Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (K $\sigma$ )(K $\alpha$ )(MSF)					
402.9	2.5	4	50	0.109	0.300	5.251	11.301	0.125	0.109	2.952	2.952	1.657	0.207	0.946	0.160	ABO. WAT.	
400.4	5	6	50	0.113	0.578	8.104	14.725	0.157	0.113	3.230	3.230	1.627	0.255	0.941	0.159	ABO. WAT.	
397.9	7.5	4	50	0.109	0.856	4.993	10.992	0.122	0.054	3.439	3.570	1.607	0.196	0.935	0.164	NL	
395.4	10	4	50	0.054	1.060	4.609	10.531	0.118	0.054	3.574	3.861	1.594	0.188	0.924	0.169	NL	
392.9	12.5	8	12	0.059	1.201	8.890	10.724	0.120	0.059	3.715	4.158	1.582	0.190	0.904	0.171	1.111	
390.4	15	7	12	0.058	1.347	7.535	9.326	0.107	0.058	3.861	4.460	1.570	0.168	0.884	0.173	0.971	
387.9	17.5	11	12	0.062	1.497	11.514	13.431	0.145	0.062	4.011	4.766	1.558	0.226	0.863	0.173	1.306	
385.4	20	5	40	0.055	1.643	5.119	11.143	0.123	0.055	4.157	5.068	1.547	0.190	0.843	0.174	1.092	
382.9	22.5	20	50	0.067	1.796	20.052	29.062	0.413	0.067	4.310	5.377	1.536	0.634	0.823	0.174	N60cs>25	
380.4	25	23	6	0.068	1.965	22.562	22.698	0.252	0.068	4.479	5.702	1.524	0.384	0.803	0.173	2.220	
377.9	27.5	11	6	0.062	2.128	10.606	10.685	0.119	0.062	4.642	6.021	1.513	0.180	0.782	0.171	1.053	
375.4	30	15	6	0.065	2.287	14.025	14.121	0.151	0.065	4.801	6.336	1.503	0.227	0.762	0.170	1.335	
372.9	32.5	15	6	0.065	2.450	13.551	13.644	0.147	0.065	4.964	6.655	1.493	0.219	0.742	0.168	1.304	
370.4	35	21	6	0.068	2.616	18.359	18.475	0.197	0.068	5.130	6.977	1.483	0.292	0.722	0.166	1.759	
367.9	37.5	28	6	0.070	2.789	23.707	23.848	0.271	0.070	5.303	7.306	1.473	0.399	0.701	0.163	2.448	
365.4	40	22	6	0.068	2.962	18.075	18.190	0.194	0.068	5.476	7.635	1.464	0.284	0.681	0.160	1.775	
362.9	42.5	26	6	0.070	3.135	20.764	20.891	0.227	0.070	5.649	7.964	1.455	0.330	0.661	0.157	2.102	
360.4	45	24	6	0.069	3.309	18.656	18.773	0.201	0.069	5.823	8.294	1.446	0.291	0.641	0.154	1.890	
357.9	47.5	24	6	0.069	3.482	18.186	18.301	0.195	0.069	5.996	8.623	1.438	0.280	0.620	0.151	1.854	
355.4	50	11	6	0.062	3.646	8.146	8.214	0.098	0.062	6.160	8.943	1.430	0.140	0.600	0.147	0.952	
352.9	52.5	11	6	0.062	3.801	7.978	8.045	0.096	0.062	6.315	9.254	1.423	0.137	0.580	0.144	0.951	
350.4	55	16	6	0.065	3.960	11.369	11.452	0.126	0.065	6.474	9.569	1.416	0.178	0.560	0.140	1.271	
347.9	57.5	32	6	0.071	4.130	21.562	21.693	0.238	0.071	6.644	9.895	1.408	0.335	0.539	0.136	2.463	
345.4	60	25	6	0.069	4.305	16.406	16.513	0.176	0.069	6.819	10.226	1.401	0.247	0.519	0.132	1.871	
342.9	62.5	36	6	0.073	4.483	23.013	23.151	0.259	0.073	6.997	10.560	1.394	0.361	0.499	0.127	2.843	
340.4	65	34	6	0.072	4.664	21.178	21.307	0.232	0.072	7.178	10.897	1.387	0.322	0.479	0.123	2.618	
337.9	67.5	28	12	0.070	4.842	17.012	19.103	0.205	0.070	7.356	11.231	1.380	0.283	0.458	0.118	2.398	
335.4	70	25	12	0.069	5.016	14.833	16.855	0.179	0.069	7.530	11.561	1.374	0.246	0.438	0.114	2.158	
332.9	72.5	83	12	0.081	5.204	48.027	51.097	1.000	0.081	7.718	11.905	1.367	1.367	0.418	0.109	N60cs>25	
330.4	75	40	12	0.074	5.398	22.570	24.836	0.289	0.074	7.912	12.255	1.360	0.393	0.398	0.104	3.779	
327.9	77.5	21	12	0.068	5.576	11.585	13.504	0.145	0.068	8.090	12.589	1.354	0.196	0.377	0.099	1.980	
325.4	80	13	6	0.063	5.740	7.027	7.090	0.088	0.063	8.254	12.909	1.349	0.119	0.357	0.094	1.266	

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO 10.5.4.2  
 \*Mag<6.0 = duration unlikely to cause Liquefaction

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-12 1000 Long period  
 ELEVATION OF BORING GROUND SURFACE ===== 413.00 FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 24.00 FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORIZ. GROUND SURFACE ACCELERATION ===== 0.100 Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 7.5 Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 11.00 FT. (Which is 1.32 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor
(K $\alpha$ )= 1.00
Earthquake Magnitude Scaling Factor
(MSF)= 1.000

Elev. of Sample (Feet)	Boring Data			Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> ) <sub>60</sub>	Fines Content Corrected (N <sub>1</sub> ) <sub>60cs</sub>	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining. Sloping & Mag. Correct. (K $\sigma$ )(K $\alpha$ )(MSF)				
410.5	2.5	9	50	0.117	0.300	11.815	19.178	0.205	0.117	2.166	2.166	0.996	0.204	0.969	0.063	ABO. WAT.
408	5	3	50	0.106	0.579	4.052	9.862	0.112	0.106	2.445	2.445	0.972	0.109	0.963	0.063	ABO. WAT.
405.5	7.5	1	50	0.097	0.833	1.265	6.518	0.084	0.097	2.699	2.699	0.953	0.080	0.957	0.062	ABO. WAT.
403	10	8	50	0.059	1.028	9.361	16.233	0.173	0.116	2.965	2.965	0.935	0.162	0.952	0.062	ABO. WAT.
400.5	12.5	7	50	0.058	1.174	7.868	14.442	0.155	0.115	3.254	3.254	0.918	0.142	0.946	0.061	ABO. WAT.
398	15	6	50	0.057	1.318	6.529	12.835	0.139	0.057	3.469	3.594	0.906	0.126	0.940	0.063	NL
395.5	17.5	3	50	0.052	1.454	3.186	8.823	0.103	0.052	3.605	3.886	0.899	0.093	0.934	0.065	NL
393	20	2	12	0.049	1.580	2.088	3.707	0.063	0.049	3.731	4.168	0.893	0.056	0.923	0.067	0.836
390.5	22.5	11	6	0.062	1.719	11.273	11.356	0.125	0.062	3.870	4.463	0.887	0.111	0.903	0.068	1.632
388	25	11	6	0.062	1.874	11.050	11.132	0.123	0.062	4.025	4.774	0.880	0.108	0.882	0.068	1.588
385.5	27.5	11	50	0.062	2.029	10.862	18.034	0.192	0.062	4.180	5.085	0.873	0.168	0.862	0.068	NL
383	30	5	50	0.055	2.175	4.794	10.753	0.120	0.055	4.326	5.387	0.867	0.104	0.842	0.068	NL
380.5	32.5	4	50	0.054	2.311	3.721	9.465	0.108	0.054	4.462	5.679	0.862	0.093	0.822	0.068	NL
378	35	21	50	0.068	2.464	18.917	27.700	0.359	0.068	4.615	5.988	0.856	0.307	0.801	0.068	N60cs>25
375.5	37.5	3	6	0.052	2.614	2.624	2.666	0.050	0.052	4.765	6.294	0.850	0.043	0.781	0.067	0.642
373	40	5	6	0.055	2.748	4.265	4.315	0.067	0.055	4.899	6.584	0.846	0.057	0.761	0.066	0.864
370.5	42.5	24	50	0.069	2.903	19.918	28.902	0.406	0.069	5.054	6.895	0.841	0.341	0.741	0.066	N60cs>25
368	45	7	6	0.058	3.062	5.656	5.712	0.077	0.058	5.213	7.210	0.835	0.064	0.720	0.065	0.985
365.5	47.5	28	6	0.070	3.222	22.057	22.190	0.245	0.070	5.373	7.526	0.830	0.203	0.700	0.064	3.172
363	50	17	6	0.066	3.392	13.052	13.143	0.142	0.066	5.543	7.852	0.825	0.117	0.680	0.063	1.857
360.5	52.5	19	6	0.067	3.558	14.243	14.340	0.153	0.067	5.709	8.174	0.820	0.125	0.660	0.061	2.049
358	55	19	6	0.067	3.726	13.918	14.013	0.150	0.067	5.877	8.498	0.816	0.122	0.639	0.060	2.033
355.5	57.5	16	6	0.065	3.891	11.469	11.553	0.127	0.065	6.042	8.819	0.811	0.103	0.619	0.059	1.746
353	60	17	6	0.066	4.055	11.588	11.672	0.128	0.066	6.206	9.139	0.807	0.103	0.599	0.057	1.807
350.5	62.5	17	6	0.066	4.220	11.299	11.382	0.126	0.066	6.371	9.460	0.802	0.101	0.579	0.056	1.804
348	65	39	6	0.073	4.394	25.258	25.406	0.300	0.073	6.545	9.790	0.798	0.239	0.558	0.054	N60cs>25
345.5	67.5	46	6	0.075	4.579	29.001	29.167	0.418	0.075	6.730	10.131	0.794	0.332	0.538	0.053	N60cs>25
343	70	29	6	0.071	4.762	17.816	17.929	0.191	0.071	6.913	10.470	0.789	0.151	0.518	0.051	2.961
340.5	72.5	35	6	0.072	4.941	20.978	21.106	0.230	0.072	7.092	10.805	0.785	0.181	0.498	0.049	3.694
338	75	19	6	0.067	5.115	11.124	11.206	0.124	0.067	7.266	11.135	0.782	0.097	0.477	0.048	2.021
335.5	77.5	42	7	0.074	5.291	24.028	24.353	0.280	0.074	7.442	11.467	0.778	0.218	0.457	0.046	4.739
333	80	50	6	0.076	5.479	27.922	28.083	0.372	0.076	7.630	11.811	0.774	0.288	0.437	0.044	N60cs>25
330.5	82.5	54	6	0.076	5.669	29.446	29.614	0.443	0.076	7.820	12.157	0.770	0.341	0.417	0.042	N60cs>25
328	85	42	6	0.074	5.857	22.381	22.516	0.250	0.074	8.008	12.501	0.767	0.192	0.396	0.040	4.800
325.5	87.5	19	12	0.067	6.033	9.956	11.824	0.130	0.067	8.184	12.833	0.763	0.099	0.376	0.038	2.605
323	90	8	12	0.059	6.191	4.192	5.878	0.079	0.059	8.342	13.147	0.760	0.060	0.356	0.036	1.667
320.5	92.5	52	12	0.076	6.360	27.248	29.662	0.446	0.076	8.511	13.472	0.757	0.338	0.336	0.035	N60cs>25
318	95	30	6	0.071	6.544	15.720	15.824	0.168	0.071	8.695	13.812	0.754	0.127	0.315	0.033	3.848
315.5	97.5	39	6	0.073	6.724	20.436	20.562	0.223	0.073	8.875	14.148	0.751	0.167	0.295	0.031	5.387
313	100	29	6	0.071	6.904	15.196	15.297	0.163	0.071	9.055	14.484	0.748	0.122	0.275	0.029	4.207
310.5	102.5	71	6	0.079	7.092	37.204	37.408	1.000	0.079	9.243	14.828	0.745	0.745	0.255	0.027	N60cs>25
308	105	56	6	0.077	7.287	29.344	29.511	0.437	0.077	9.438	15.179	0.742	0.324	0.234	0.024	N60cs>25
305.5	107.5	100	6	0.083	7.487	52.400	52.676	1.000	0.083	9.638	15.535	0.739	0.739	0.214	0.022	N60cs>25
303	110	100	6	0.083	7.695	52.400	52.676	1.000	0.083	9.846	15.899	0.736	0.736	0.194	0.020	N60cs>25
300.5	112.5	100	6	0.083	7.903	52.400	52.676	1.000	0.083	10.054	16.263	0.732	0.732	0.174	0.018	N60cs>25
299.5	113.5	100	5	0.083	7.986	52.400	52.400	1.000	0.083	10.137	16.408	0.731	0.731	0.166	0.017	N60cs>25

\*ABO.WAT. = ABOVE WATER TABLE

\*NL = NOT LIQUEFIABLE

\*ABO.GRA.=ABOVE FINISHED GRADE

\*(N1)60cs&gt;25 = not liquefiable by AASHTO

\*Mag&lt;6.0 = duration unlikely to cause Lique

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER =====WB-12===== 1000 Short period  
 ELEVATION OF BORING GROUND SURFACE ===== 413.00 FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 24.00 FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.190 Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 5.6 Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 11.00 FT. (Which is 1.32 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(Ka)=</b> 1.00
Earthquake Magnitude Scaling Factor <b>(MSF)=</b> 2.112

Elev. of Sample (Feet)	Boring Data			Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> )60	Fines Content Corrected (N <sub>1</sub> )60cs	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining. Sloping & Mag. Correct. (Kσ)(Kω)(MSF)				
410.5	2.5	9	50	0.117	0.300	11.815	19.178	0.205	0.117	2.166	2.166	2.103	0.431	0.969	0.120	ABO. WAT.
408	5	3	50	0.106	0.579	4.052	9.862	0.112	0.106	2.445	2.445	2.053	0.230	0.963	0.119	ABO. WAT.
405.5	7.5	1	50	0.097	0.833	1.265	6.518	0.084	0.097	2.699	2.699	2.012	0.169	0.957	0.118	ABO. WAT.
403	10	8	50	0.059	1.028	9.361	16.233	0.173	0.116	2.965	2.965	1.975	0.342	0.952	0.118	ABO. WAT.
400.5	12.5	7	50	0.058	1.174	7.868	14.442	0.155	0.115	3.254	3.254	1.939	0.301	0.946	0.117	ABO. WAT.
398	15	6	50	0.057	1.318	6.529	12.835	0.139	0.057	3.469	3.594	1.914	0.266	0.940	0.120	NL
395.5	17.5	3	50	0.052	1.454	3.186	8.823	0.103	0.052	3.605	3.886	1.899	0.196	0.934	0.124	NL
393	20	2	12	0.049	1.580	2.088	3.707	0.063	0.049	3.731	4.168	1.886	0.119	0.923	0.127	0.937
390.5	22.5	11	6	0.062	1.719	11.273	11.356	0.125	0.062	3.870	4.463	1.872	0.234	0.903	0.129	1.814
388	25	11	6	0.062	1.874	11.050	11.132	0.123	0.062	4.025	4.774	1.858	0.229	0.882	0.129	1.775
385.5	27.5	11	50	0.062	2.029	10.862	18.034	0.192	0.062	4.180	5.085	1.844	0.354	0.862	0.130	NL
383	30	5	50	0.055	2.175	4.794	10.753	0.120	0.055	4.326	5.387	1.831	0.220	0.842	0.129	NL
380.5	32.5	4	50	0.054	2.311	3.721	9.465	0.108	0.054	4.462	5.679	1.820	0.197	0.822	0.129	NL
378	35	21	50	0.068	2.464	18.917	27.700	0.359	0.068	4.615	5.988	1.808	0.649	0.801	0.128	N60cs>25
375.5	37.5	3	6	0.052	2.614	2.624	2.666	0.050	0.052	4.765	6.294	1.796	0.090	0.781	0.127	0.709
373	40	5	6	0.055	2.748	4.265	4.315	0.067	0.055	4.899	6.584	1.786	0.120	0.761	0.126	0.952
370.5	42.5	24	50	0.069	2.903	19.918	28.902	0.406	0.069	5.054	6.895	1.775	0.721	0.741	0.125	N60cs>25
368	45	7	6	0.058	3.062	5.656	5.712	0.077	0.058	5.213	7.210	1.764	0.136	0.720	0.123	1.106
365.5	47.5	28	6	0.070	3.222	22.057	22.190	0.245	0.070	5.373	7.526	1.754	0.430	0.700	0.121	3.554
363	50	17	6	0.066	3.392	13.052	13.143	0.142	0.066	5.543	7.852	1.743	0.248	0.680	0.119	2.084
360.5	52.5	19	6	0.067	3.558	14.243	14.340	0.153	0.067	5.709	8.174	1.732	0.265	0.660	0.117	2.265
358	55	19	6	0.067	3.726	13.918	14.013	0.150	0.067	5.877	8.498	1.722	0.258	0.639	0.114	2.263
355.5	57.5	16	6	0.065	3.891	11.469	11.553	0.127	0.065	6.042	8.819	1.713	0.218	0.619	0.112	1.946
353	60	17	6	0.066	4.055	11.588	11.672	0.128	0.066	6.206	9.139	1.704	0.218	0.599	0.109	2.000
350.5	62.5	17	6	0.066	4.220	11.299	11.382	0.126	0.066	6.371	9.460	1.695	0.214	0.579	0.106	2.019
348	65	39	6	0.073	4.394	25.258	25.406	0.300	0.073	6.545	9.790	1.686	0.506	0.558	0.103	N60cs>25
345.5	67.5	46	6	0.075	4.579	29.001	29.167	0.418	0.075	6.730	10.131	1.676	0.701	0.538	0.100	N60cs>25
343	70	29	6	0.071	4.762	17.816	17.929	0.191	0.071	6.913	10.470	1.667	0.318	0.518	0.097	3.278
340.5	72.5	35	6	0.072	4.941	20.978	21.106	0.230	0.072	7.092	10.805	1.659	0.382	0.498	0.094	4.064
338	75	19	6	0.067	5.115	11.124	11.206	0.124	0.067	7.266	11.135	1.651	0.205	0.477	0.090	2.278
335.5	77.5	42	7	0.074	5.291	24.028	24.353	0.280	0.074	7.442	11.467	1.643	0.460	0.457	0.087	5.287
333	80	50	6	0.076	5.479	27.922	28.083	0.372	0.076	7.630	11.811	1.635	0.608	0.437	0.084	N60cs>25
330.5	82.5	54	6	0.076	5.669	29.446	29.614	0.443	0.076	7.820	12.157	1.627	0.721	0.417	0.080	N60cs>25
328	85	42	6	0.074	5.857	22.381	22.516	0.250	0.074	8.008	12.501	1.619	0.405	0.396	0.076	5.329
325.5	87.5	19	12	0.067	6.033	9.956	11.824	0.130	0.067	8.184	12.833	1.612	0.210	0.376	0.073	2.877
323	90	8	12	0.059	6.191	4.192	5.878	0.079	0.059	8.342	13.147	1.606	0.127	0.356	0.069	1.841
320.5	92.5	52	12	0.076	6.360	27.248	29.662	0.446	0.076	8.511	13.472	1.599	0.713	0.336	0.066	N60cs>25
318	95	30	6	0.071	6.544	15.720	15.824	0.168	0.071	8.695	13.812	1.593	0.268	0.315	0.062	4.323
315.5	97.5	39	6	0.073	6.724	20.436	20.562	0.223	0.073	8.875	14.148	1.586	0.354	0.295	0.058	6.103
313	100	29	6	0.071	6.904	15.196	15.297	0.163	0.071	9.055	14.484	1.580	0.258	0.275	0.054	4.778
310.5	102.5	71	6	0.079	7.092	37.204	37.408	1.000	0.079	9.243	14.828	1.573	1.573	0.255	0.051	N60cs>25
308	105	56	6	0.077	7.287	29.344	29.511	0.437	0.077	9.438	15.179	1.567	0.685	0.234	0.046	N60cs>25
305.5	107.5	100	6	0.083	7.487	52.400	52.676	1.000	0.083	9.638	15.535	1.560	1.560	0.214	0.043	N60cs>25
303	110	100	6	0.083	7.695	52.400	52.676	1.000	0.083	9.846	15.899	1.553	1.553	0.194	0.039	N60cs>25
300.5	112.5	100	6	0.083	7.903	52.400	52.676	1.000	0.083	10.054	16.263	1.547	1.547	0.174	0.035	N60cs>25
299.5	113.5	100	5	0.083	7.986	52.400	52.400	1.000	0.083	10.137	16.408	1.544	1.544	0.166	0.033	N60cs>25

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO  
 \*Mag<6.0 = duration unlikely to cause Lique

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== WB-12 2500 Long period  
 ELEVATION OF BORING GROUND SURFACE ===== 413.00 FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== 8.50 FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== 24.00 FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== 0.120 Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== 7.7 Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== 11.00 FT. (Which is 1.32 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== 2 (1=Yes OR 2=No)

Sloped Ground
Shear Stress
Correct. Factor
(K $\alpha$ )= 1.00
Earthquake
Magnitude
Scaling Factor
(MSF)= 0.935

Elev. of Sample (Feet)	Boring Data			Conditions During Drilling				Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR	
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> )60	Fines Content Corrected (N <sub>1</sub> )60cs	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)					Confining. Sloping & Mag. Correct. (K $\sigma$ )(K $\alpha$ )(MSF)
410.5	2.5	9	50	0.117	0.300	11.815	19.178	0.205	0.117	2.166	2.166	0.931	0.191	0.969	0.076	ABO. WAT.
408	5	3	50	0.106	0.579	4.052	9.862	0.112	0.106	2.445	2.445	0.909	0.102	0.963	0.075	ABO. WAT.
405.5	7.5	1	50	0.097	0.833	1.265	6.518	0.084	0.097	2.699	2.699	0.891	0.075	0.957	0.075	ABO. WAT.
403	10	8	50	0.059	1.028	9.361	16.233	0.173	0.116	2.965	2.965	0.874	0.151	0.952	0.074	ABO. WAT.
400.5	12.5	7	50	0.058	1.174	7.868	14.442	0.155	0.115	3.254	3.254	0.858	0.133	0.946	0.074	ABO. WAT.
398	15	6	50	0.057	1.318	6.529	12.835	0.139	0.057	3.469	3.594	0.847	0.118	0.940	0.076	NL
395.5	17.5	3	50	0.052	1.454	3.186	8.823	0.103	0.052	3.605	3.886	0.841	0.087	0.934	0.079	NL
393	20	2	12	0.049	1.580	2.088	3.707	0.063	0.049	3.731	4.168	0.835	0.053	0.923	0.080	0.663
390.5	22.5	11	6	0.062	1.719	11.273	11.356	0.125	0.062	3.870	4.463	0.829	0.104	0.903	0.081	1.284
388	25	11	6	0.062	1.874	11.050	11.132	0.123	0.062	4.025	4.774	0.822	0.101	0.882	0.082	1.232
385.5	27.5	11	50	0.062	2.029	10.862	18.034	0.192	0.062	4.180	5.085	0.816	0.157	0.862	0.082	NL
383	30	5	50	0.055	2.175	4.794	10.753	0.120	0.055	4.326	5.387	0.811	0.097	0.842	0.082	NL
380.5	32.5	4	50	0.054	2.311	3.721	9.465	0.108	0.054	4.462	5.679	0.806	0.087	0.822	0.082	NL
378	35	21	50	0.068	2.464	18.917	27.700	0.359	0.068	4.615	5.988	0.800	0.287	0.801	0.081	N60cs>25
375.5	37.5	3	6	0.052	2.614	2.624	2.666	0.050	0.052	4.765	6.294	0.795	0.040	0.781	0.080	0.500
373	40	5	6	0.055	2.748	4.265	4.315	0.067	0.055	4.899	6.584	0.791	0.053	0.761	0.080	0.663
370.5	42.5	24	50	0.069	2.903	19.918	28.902	0.406	0.069	5.054	6.895	0.786	0.319	0.741	0.079	N60cs>25
368	45	7	6	0.058	3.062	5.656	5.712	0.077	0.058	5.213	7.210	0.781	0.060	0.720	0.078	0.769
365.5	47.5	28	6	0.070	3.222	22.057	22.190	0.245	0.070	5.373	7.526	0.776	0.190	0.700	0.076	2.500
363	50	17	6	0.066	3.392	13.052	13.143	0.142	0.066	5.543	7.852	0.771	0.109	0.680	0.075	1.453
360.5	52.5	19	6	0.067	3.558	14.243	14.340	0.153	0.067	5.709	8.174	0.767	0.117	0.660	0.074	1.581
358	55	19	6	0.067	3.726	13.918	14.013	0.150	0.067	5.877	8.498	0.763	0.114	0.639	0.072	1.583
355.5	57.5	16	6	0.065	3.891	11.469	11.553	0.127	0.065	6.042	8.819	0.758	0.096	0.619	0.070	1.371
353	60	17	6	0.066	4.055	11.588	11.672	0.128	0.066	6.206	9.139	0.754	0.097	0.599	0.069	1.406
350.5	62.5	17	6	0.066	4.220	11.299	11.382	0.126	0.066	6.371	9.460	0.750	0.095	0.579	0.067	1.418
348	65	39	6	0.073	4.394	25.258	25.406	0.300	0.073	6.545	9.790	0.746	0.224	0.558	0.065	N60cs>25
345.5	67.5	46	6	0.075	4.579	29.001	29.167	0.418	0.075	6.730	10.131	0.742	0.310	0.538	0.063	N60cs>25
343	70	29	6	0.071	4.762	17.816	17.929	0.191	0.071	6.913	10.470	0.738	0.141	0.518	0.061	2.311
340.5	72.5	35	6	0.072	4.941	20.978	21.106	0.230	0.072	7.092	10.805	0.734	0.169	0.498	0.059	2.864
338	75	19	6	0.067	5.115	11.124	11.206	0.124	0.067	7.266	11.135	0.731	0.091	0.477	0.057	1.596
335.5	77.5	42	7	0.074	5.291	24.028	24.353	0.280	0.074	7.442	11.467	0.727	0.204	0.457	0.055	3.709
333	80	50	6	0.076	5.479	27.922	28.083	0.372	0.076	7.630	11.811	0.724	0.269	0.437	0.053	N60cs>25
330.5	82.5	54	6	0.076	5.669	29.446	29.614	0.443	0.076	7.820	12.157	0.720	0.319	0.417	0.051	N60cs>25
328	85	42	6	0.074	5.857	22.381	22.516	0.250	0.074	8.008	12.501	0.717	0.179	0.396	0.048	3.729
325.5	87.5	19	12	0.067	6.033	9.956	11.824	0.130	0.067	8.184	12.833	0.714	0.093	0.376	0.046	2.022
323	90	8	12	0.059	6.191	4.192	5.878	0.079	0.059	8.342	13.147	0.711	0.056	0.356	0.044	1.273
320.5	92.5	52	12	0.076	6.360	27.248	29.662	0.446	0.076	8.511	13.472	0.708	0.316	0.336	0.041	N60cs>25
318	95	30	6	0.071	6.544	15.720	15.824	0.168	0.071	8.695	13.812	0.705	0.118	0.315	0.039	3.026
315.5	97.5	39	6	0.073	6.724	20.436	20.562	0.223	0.073	8.875	14.148	0.702	0.157	0.295	0.037	4.243
313	100	29	6	0.071	6.904	15.196	15.297	0.163	0.071	9.055	14.484	0.699	0.114	0.275	0.034	3.353
310.5	102.5	71	6	0.079	7.092	37.204	37.408	1.000	0.079	9.243	14.828	0.696	0.696	0.255	0.032	N60cs>25
308	105	56	6	0.077	7.287	29.344	29.511	0.437	0.077	9.438	15.179	0.694	0.303	0.234	0.029	N60cs>25
305.5	107.5	100	6	0.083	7.487	52.400	52.676	1.000	0.083	9.638	15.535	0.691	0.691	0.214	0.027	N60cs>25
303	110	100	6	0.083	7.695	52.400	52.676	1.000	0.083	9.846	15.899	0.688	0.688	0.194	0.024	N60cs>25
300.5	112.5	100	6	0.083	7.903	52.400	52.676	1.000	0.083	10.054	16.263	0.685	0.685	0.174	0.022	N60cs>25
299.5	113.5	100	5	0.083	7.986	52.400	52.400	1.000	0.083	10.137	16.408	0.684	0.684	0.166	0.021	N60cs>25

\*ABO.WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO.GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO  
 \*Mag<6.0 = duration unlikely to cause Lique

# LIQUEFACTION ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT

Modified on 9/15/08

REFERENCE BORING NUMBER ===== **WB-12** **2500 Short period**  
 ELEVATION OF BORING GROUND SURFACE ===== **413.00** FT.  
 DEPTH TO GROUNDWATER DURING DRILLING ===== **8.50** FT. (Below Boring Ground Surface)  
 DEPTH TO GROUNDWATER DURING EARTHQUAKE ===== **24.00** FT. (Below Finished Grade Cut or Fill Surface)  
 MAX. HORZ. GROUND SURFACE ACCELERATION ===== **0.260** Coefficient of Gravity  
 DESIGN EARTHQUAKE MEAN MAGNITUDE ===== **6.0** Moment Magnitude Scale  
 FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===== **11.00** FT. (Which is 1.32 ksf Effect. Surch. Fill Press.)  
 ADJUST DIST. #9 N VALUES TO 60% ENERGY TRANSFER ===== **2** (1=Yes OR 2=No)

Sloped Ground Shear Stress Correct. Factor <b>(Kα)= 1.00</b>
Earthquake Magnitude Scaling Factor <b>(MSF)= 1.770</b>

Elev. of Sample (Feet)	Boring Data			Conditions During Drilling					Conditions During Earthquake				Corrected CRR <sub>7.5</sub> Resisting CRR	Stress Reduct. Factor (rd)	Earth Quake Induced CSR	FACTOR OF SAFETY* CRR/CSR
	Boring Sample Depth (Feet)	S.P.T. N Value (Blows)	% Fines < #200 (%)	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Overburd. & Drillrod Corrected (N <sub>1</sub> )60	Fines Content Corrected (N <sub>1</sub> )60cs	CRR Resisting Mag 7.5 CRR <sub>7.5</sub>	Effect. Unit Weight (KCF.)	Effect. Vertical Stress (KSF.)	Total Vertical Stress (KSF.)	Confining, Sloping & Mag. Correct. (Kσ)(Kα)(MSF)				
410.5	2.5	9	50	0.117	0.300	11.815	19.178	0.205	0.117	2.166	2.166	1.762	0.361	0.969	0.164	ABO. WAT.
408	5	3	50	0.106	0.579	4.052	9.862	0.112	0.106	2.445	2.445	1.720	0.193	0.963	0.163	ABO. WAT.
405.5	7.5	1	50	0.097	0.833	1.265	6.518	0.084	0.097	2.699	2.699	1.687	0.142	0.957	0.162	ABO. WAT.
403	10	8	50	0.059	1.028	9.361	16.233	0.173	0.116	2.965	2.965	1.655	0.286	0.952	0.161	ABO. WAT.
400.5	12.5	7	50	0.058	1.174	7.868	14.442	0.155	0.115	3.254	3.254	1.625	0.252	0.946	0.160	ABO. WAT.
398	15	6	50	0.057	1.318	6.529	12.835	0.139	0.057	3.469	3.594	1.604	0.223	0.940	0.165	NL
395.5	17.5	3	50	0.052	1.454	3.186	8.823	0.103	0.052	3.605	3.886	1.592	0.164	0.934	0.170	NL
393	20	2	12	0.049	1.580	2.088	3.707	0.063	0.049	3.731	4.168	1.581	0.100	0.923	0.174	0.575
390.5	22.5	11	6	0.062	1.719	11.273	11.356	0.125	0.062	3.870	4.463	1.569	0.196	0.903	0.176	1.114
388	25	11	6	0.062	1.874	11.050	11.132	0.123	0.062	4.025	4.774	1.557	0.192	0.882	0.177	1.085
385.5	27.5	11	50	0.062	2.029	10.862	18.034	0.192	0.062	4.180	5.085	1.545	0.297	0.862	0.177	NL
383	30	5	50	0.055	2.175	4.794	10.753	0.120	0.055	4.326	5.387	1.535	0.184	0.842	0.177	NL
380.5	32.5	4	50	0.054	2.311	3.721	9.465	0.108	0.054	4.462	5.679	1.525	0.165	0.822	0.177	NL
378	35	21	50	0.068	2.464	18.917	27.700	0.359	0.068	4.615	5.988	1.515	0.544	0.801	0.176	N60cs>25
375.5	37.5	3	6	0.052	2.614	2.624	2.666	0.050	0.052	4.765	6.294	1.505	0.075	0.781	0.174	0.431
373	40	5	6	0.055	2.748	4.265	4.315	0.067	0.055	4.899	6.584	1.497	0.100	0.761	0.173	0.578
370.5	42.5	24	50	0.069	2.903	19.918	28.902	0.406	0.069	5.054	6.895	1.488	0.604	0.741	0.171	N60cs>25
368	45	7	6	0.058	3.062	5.656	5.712	0.077	0.058	5.213	7.210	1.479	0.114	0.720	0.168	0.679
365.5	47.5	28	6	0.070	3.222	22.057	22.190	0.245	0.070	5.373	7.526	1.470	0.360	0.700	0.166	2.169
363	50	17	6	0.066	3.392	13.052	13.143	0.142	0.066	5.543	7.852	1.460	0.207	0.680	0.163	1.270
360.5	52.5	19	6	0.067	3.558	14.243	14.340	0.153	0.067	5.709	8.174	1.452	0.222	0.660	0.160	1.388
358	55	19	6	0.067	3.726	13.918	14.013	0.150	0.067	5.877	8.498	1.443	0.216	0.639	0.156	1.385
355.5	57.5	16	6	0.065	3.891	11.469	11.553	0.127	0.065	6.042	8.819	1.436	0.182	0.619	0.153	1.190
353	60	17	6	0.066	4.055	11.588	11.672	0.128	0.066	6.206	9.139	1.428	0.183	0.599	0.149	1.228
350.5	62.5	17	6	0.066	4.220	11.299	11.382	0.126	0.066	6.371	9.460	1.420	0.179	0.579	0.145	1.234
348	65	39	6	0.073	4.394	25.258	25.406	0.300	0.073	6.545	9.790	1.413	0.424	0.558	0.141	N60cs>25
345.5	67.5	46	6	0.075	4.579	29.001	29.167	0.418	0.075	6.730	10.131	1.405	0.587	0.538	0.137	N60cs>25
343	70	29	6	0.071	4.762	17.816	17.929	0.191	0.071	6.913	10.470	1.397	0.267	0.518	0.133	2.008
340.5	72.5	35	6	0.072	4.941	20.978	21.106	0.230	0.072	7.092	10.805	1.390	0.320	0.498	0.128	2.500
338	75	19	6	0.067	5.115	11.124	11.206	0.124	0.067	7.266	11.135	1.384	0.172	0.477	0.124	1.387
335.5	77.5	42	7	0.074	5.291	24.028	24.353	0.280	0.074	7.442	11.467	1.377	0.386	0.457	0.119	3.244
333	80	50	6	0.076	5.479	27.922	28.083	0.372	0.076	7.630	11.811	1.370	0.510	0.437	0.114	N60cs>25
330.5	82.5	54	6	0.076	5.669	29.446	29.614	0.443	0.076	7.820	12.157	1.363	0.604	0.417	0.110	N60cs>25
328	85	42	6	0.074	5.857	22.381	22.516	0.250	0.074	8.008	12.501	1.357	0.339	0.396	0.104	3.260
325.5	87.5	19	12	0.067	6.033	9.956	11.824	0.130	0.067	8.184	12.833	1.351	0.176	0.376	0.100	1.760
323	90	8	12	0.059	6.191	4.192	5.878	0.079	0.059	8.342	13.147	1.346	0.106	0.356	0.095	1.116
320.5	92.5	52	12	0.076	6.360	27.248	29.662	0.446	0.076	8.511	13.472	1.340	0.598	0.336	0.090	N60cs>25
318	95	30	6	0.071	6.544	15.720	15.824	0.168	0.071	8.695	13.812	1.335	0.224	0.315	0.085	2.635
315.5	97.5	39	6	0.073	6.724	20.436	20.562	0.223	0.073	8.875	14.148	1.329	0.296	0.295	0.079	3.747
313	100	29	6	0.071	6.904	15.196	15.297	0.163	0.071	9.055	14.484	1.324	0.216	0.275	0.074	2.919
310.5	102.5	71	6	0.079	7.092	37.204	37.408	1.000	0.079	9.243	14.828	1.318	1.318	0.255	0.069	N60cs>25
308	105	56	6	0.077	7.287	29.344	29.511	0.437	0.077	9.438	15.179	1.313	0.574	0.234	0.064	N60cs>25
305.5	107.5	100	6	0.083	7.487	52.400	52.676	1.000	0.083	9.638	15.535	1.308	1.308	0.214	0.058	N60cs>25
303	110	100	6	0.083	7.695	52.400	52.676	1.000	0.083	9.846	15.899	1.302	1.302	0.194	0.053	N60cs>25
300.5	112.5	100	6	0.083	7.903	52.400	52.676	1.000	0.083	10.054	16.263	1.297	1.297	0.174	0.048	N60cs>25
299.5	113.5	100	5	0.083	7.986	52.400	52.400	1.000	0.083	10.137	16.408	1.294	1.294	0.166	0.045	N60cs>25

\*ABO. WAT. = ABOVE WATER TABLE  
 \*NL = NOT LIQUEFIABLE  
 \*ABO. GRA.=ABOVE FINISHED GRADE  
 \*(N1)60cs>25 = not liquefiable by AASHTO  
 \*Mag<6.0 = duration unlikely to cause Lique

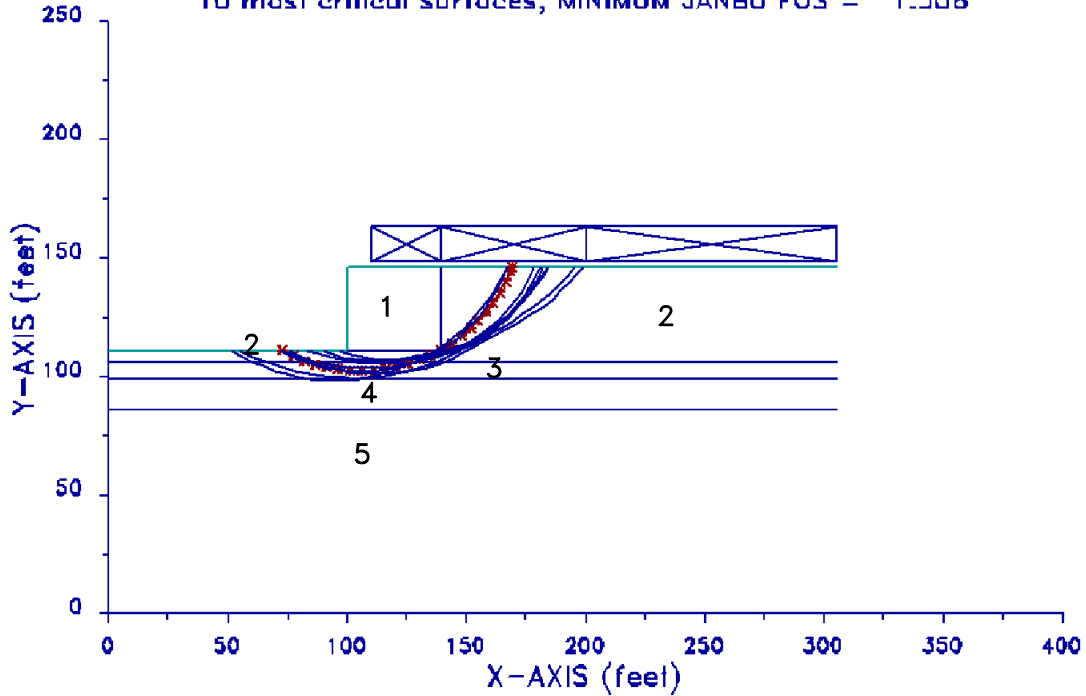
## **APPENDIX H**

### **SLOPE STABILITY X-STABL OUTPUT**



MSE STA439 0.00g

10 most critical surfaces, MINIMUM JANBU FOS = 1.506

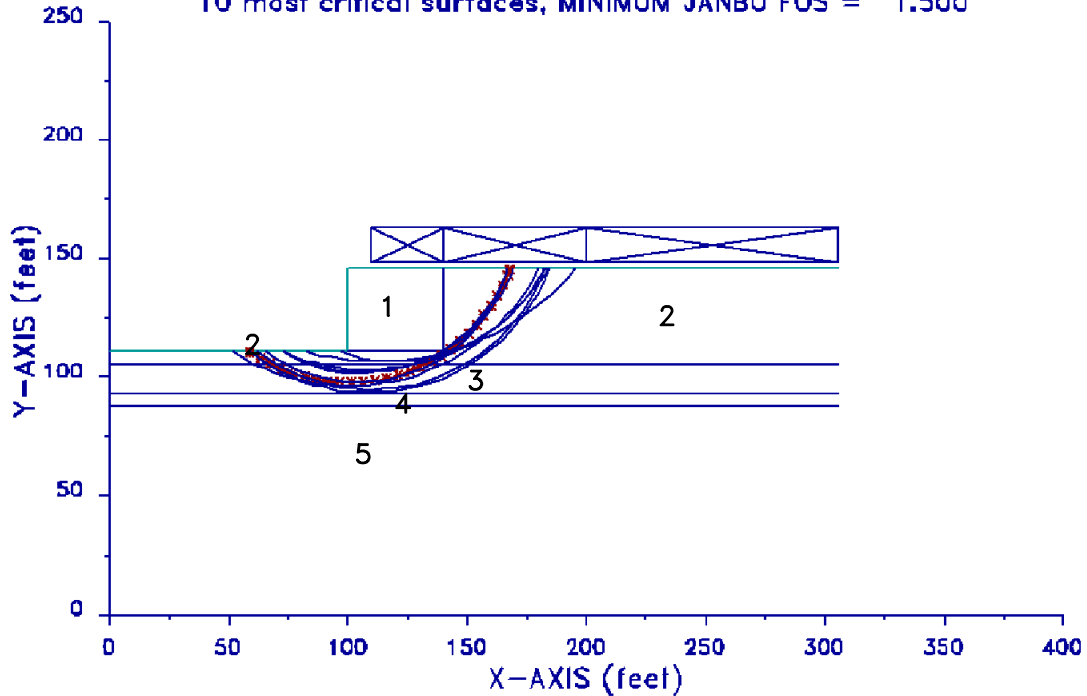


SB-10 Regular Profile STA 439+50  
Non-Seismic

Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125	1250		0	Iso, Conven M-C
4	120	125		30	0	Iso, Conven M-C
5	120	125		32	0	Iso, Conven M-C

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		DATE	December 22, 2009
		GSI JOB No.	08201

MSE STA440 0.00g  
 10 most critical surfaces, MINIMUM JANBU FOS = 1.500

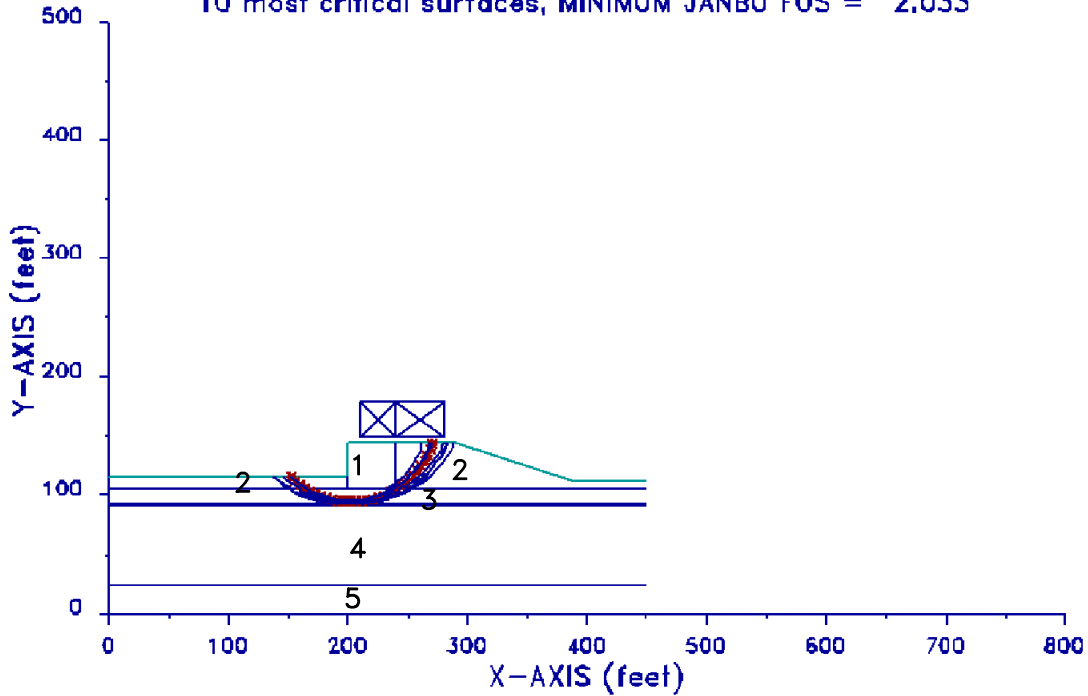


SB-09 Regular Profile STA 440+23  
 Non-Seismic

Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125	1250		0	Iso, Conven M-C
4	120	125		29	0	Iso, Conven M-C
5	120	125		32	0	Iso, Conven M-C

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		GSI JOB No.	08201

MSE STA441 0.00g  
 10 most critical surfaces, MINIMUM JANBU FOS = 2.033



WB-01 Regular Profile STA 441+23  
 Non-Seismic

Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125	850		0	Iso, Conven M-C
4	120	125		30	0	Iso, Conven M-C
5	120	125		30	0	Iso, Conven M-C
6	120	125		30	0	Iso, Conven M-C

MSE Wall Slope Stability STA 441+23  
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 IDOT Job: D-93-059-08 (PTB 146, Item1)  
 St. Claire County, Illinois

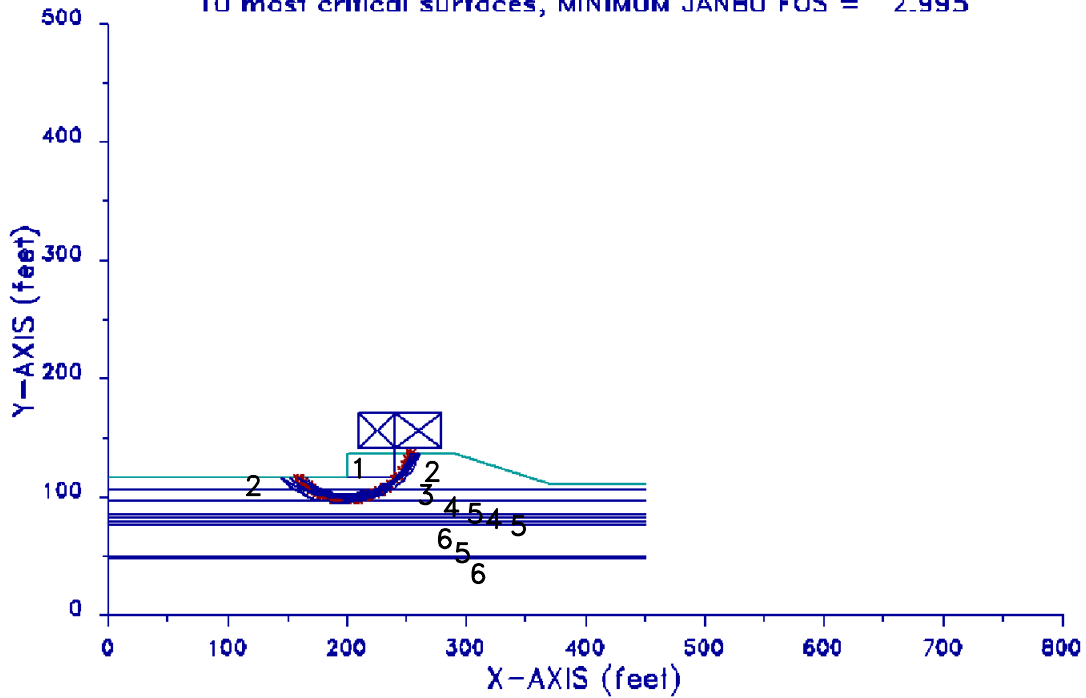


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MSE STA 443 0.00g

10 most critical surfaces, MINIMUM JANBU FOS = 2.995



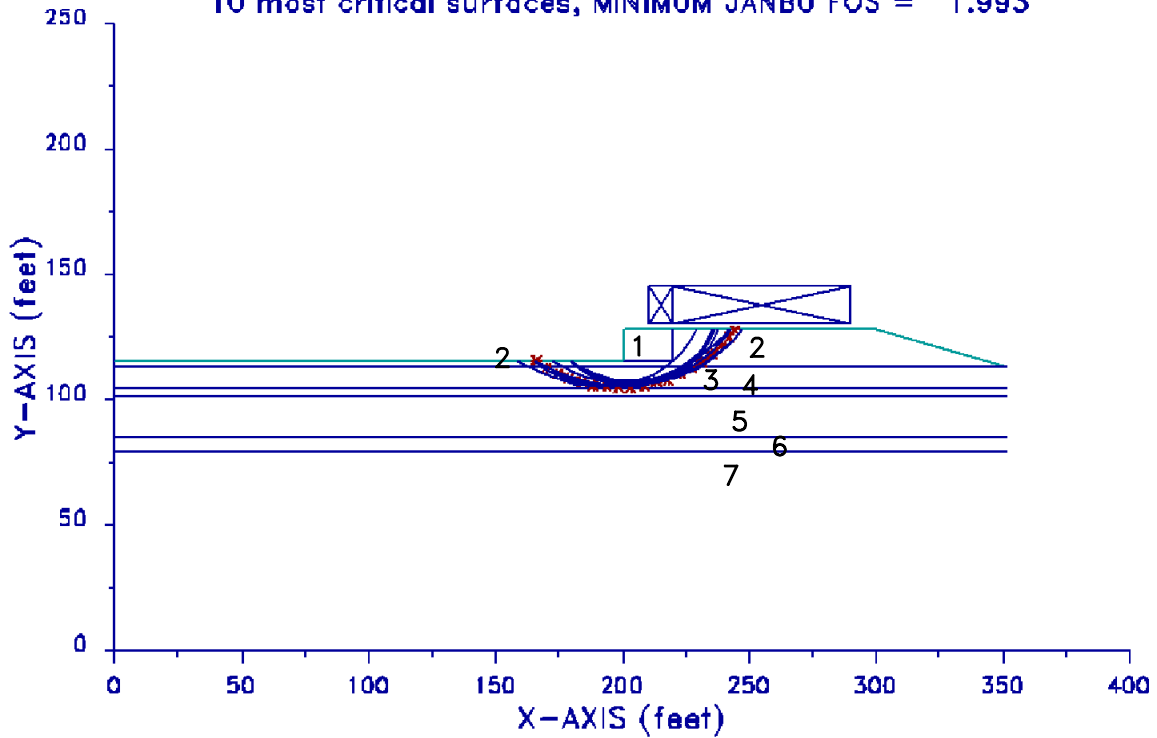
WB-06 Regular Profile STA 443+70  
Non-Seismic

Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125	1000		0	Iso, Conven M-C
4	120	125		28	0	Iso, Conven M-C
5	120	125		30	0	Iso, Conven M-C
6	120	125		30	0	Iso, Conven M-C

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		DATE	December 22, 2009
		GSI JOB No.	08201

**MSE STA447 0.19g**

**10 most critical surfaces, MINIMUM JANBU FOS = 1.993**



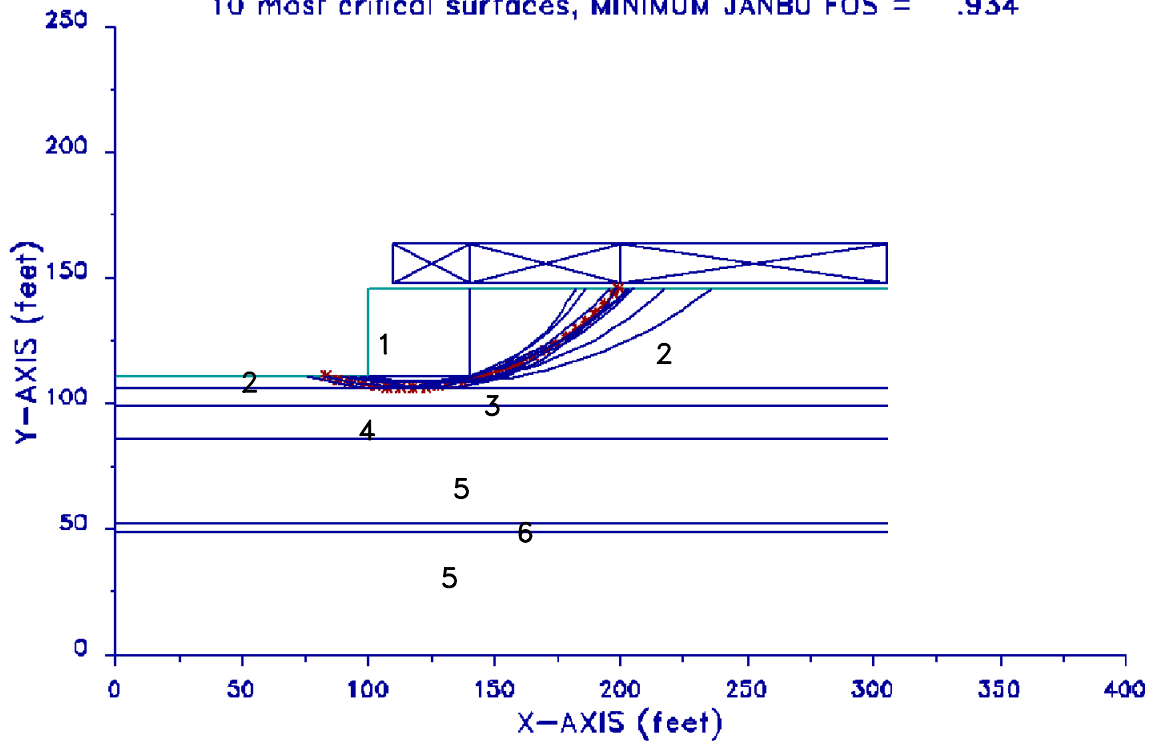
**WB-12 Regular Profile STA 447+50  
Non-Seismic**

Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Saturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125		10	0	Iso, Conven M-C
4	120	125	2000		0	Iso, Conven M-C
5	120	125		28		
6	120	125	500			
7	120	125		36	0	Iso, Conven M-C

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		DATE	December 22, 2009
		GSI JOB No.	08201

MSE STA439 0.19g

10 most critical surfaces, MINIMUM JANBU FOS = .934



SB-10 Liquefaction STA 439+50  
 75% 0.26g (0.19g)  
 2500 YR-Short Period

Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125	1250		0	Iso, Conven M-C
4	120	125		30	0	Iso, Conven M-C
5	120	125		32	0	Iso, Conven M-C
6	120	125		6	0	Iso, Conven M-C

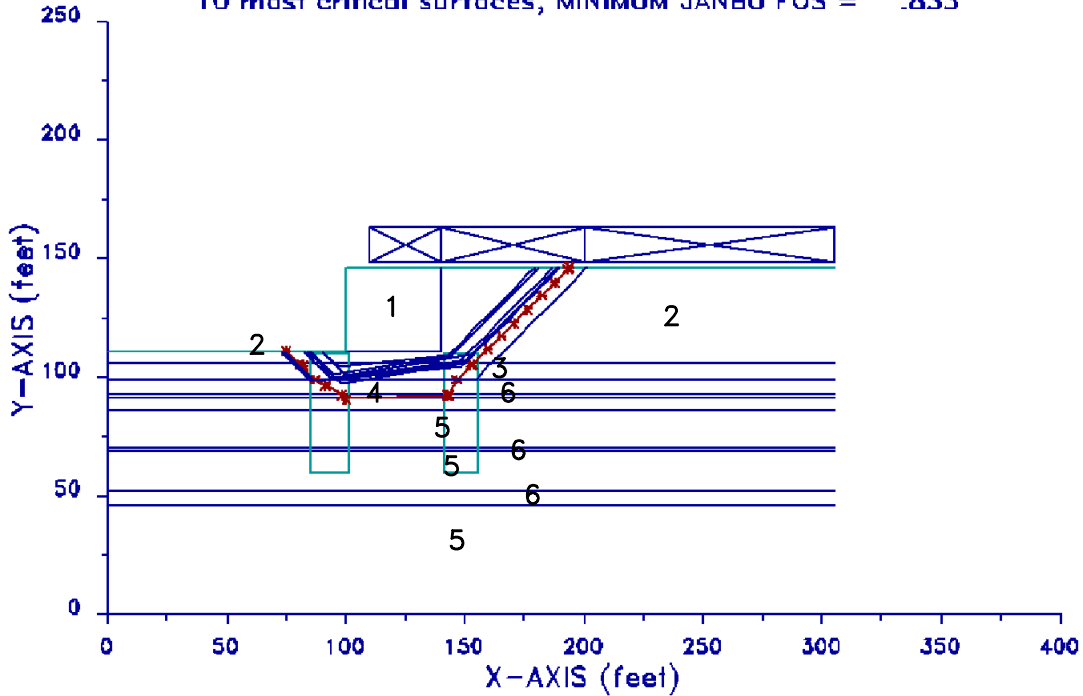
MSE Wall Slope Stability STA 439+50  
 STRUCTURE GEOTECHNICAL REPORT for  
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 I-70 Bridge Approach, Mississippi River  
 IDOT Job: D-93-059-08 (PTB 146, Item1)  
 St. Claire County, Illinois



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MSE STA439 0.19g B

10 most critical surfaces, MINIMUM JANBU FOS = .833

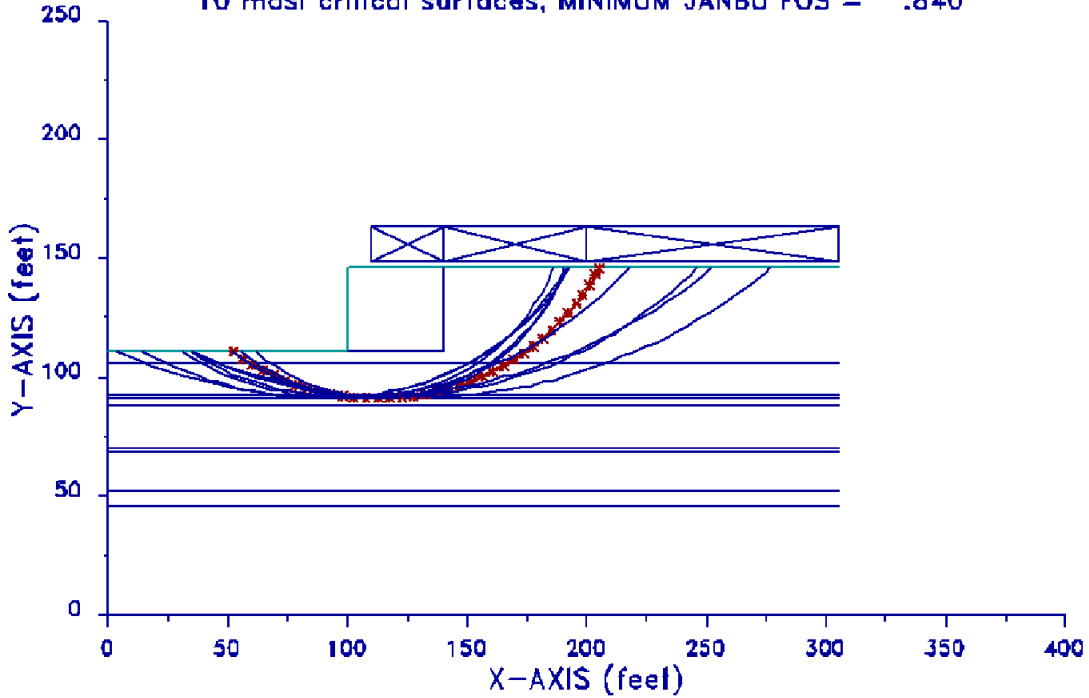


SB-10 Liquefaction STA 439+50  
 75% 0.26g (0.19g) Block  
 2500 YR-Short Period

Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125	1250		0	Iso, Conven M-C
4	120	125		30	0	Iso, Conven M-C
5	120	125		32	0	Iso, Conven M-C
6	120	125		6	0	Iso, Conven M-C

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		GSI JOB No.	08201

MSE STA440 0.19g  
 10 most critical surfaces, MINIMUM JANBU FOS = .840



SB-09 Regular Profile STA 440+23  
 75% 0.26g (0.19g)  
 2500 YR-Short Period

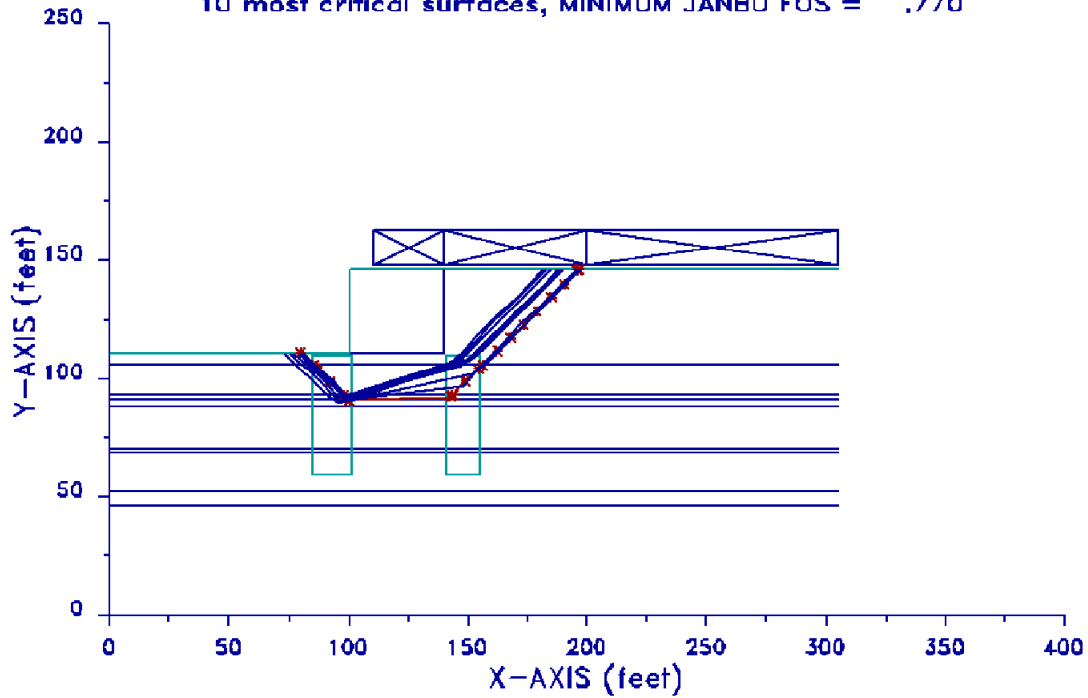
Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125	1250		0	Iso, Conven M-C
4	120	125		29	0	Iso, Conven M-C
5	120	125		32		
6	120	125		6	0	Iso, Conven M-C

MSE Wall Slope Stability STA 440+23	 <b>Geo Services, Inc.</b> Geotechnical, Environmental & Civil Engineering 805 Amherst Court, Suite 204 Naperville, Illinois 60565 (630) 355-2838	DRAWN BY	AUB
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		GSI JOB No.	08201



**MSE STA440 0.19 B**

10 most critical surfaces, MINIMUM JANBU FOS = .770



SB-09 Regular Profile STA 440+23  
 75% 0.26g (0.19g) Block  
 2500 YR-Short Period

Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125	1250		0	Iso, Conven M-C
4	120	125		29	0	Iso, Conven M-C
5	120	125		32		
6	120	125		6	0	Iso, Conven M-C

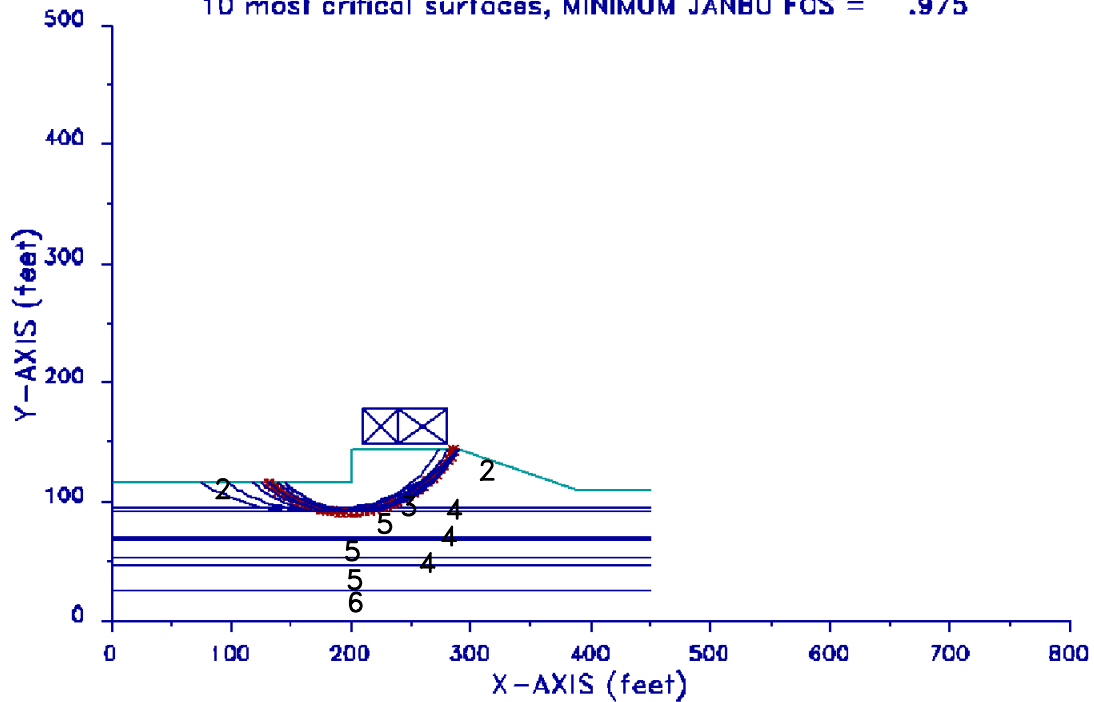
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 STRUCTURE GEOTECHNICAL REPORT for  
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 I-70 Bridge Approach, Mississippi River  
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MSE STA441 0.19g

10 most critical surfaces, MINIMUM JANBU FOS = .975



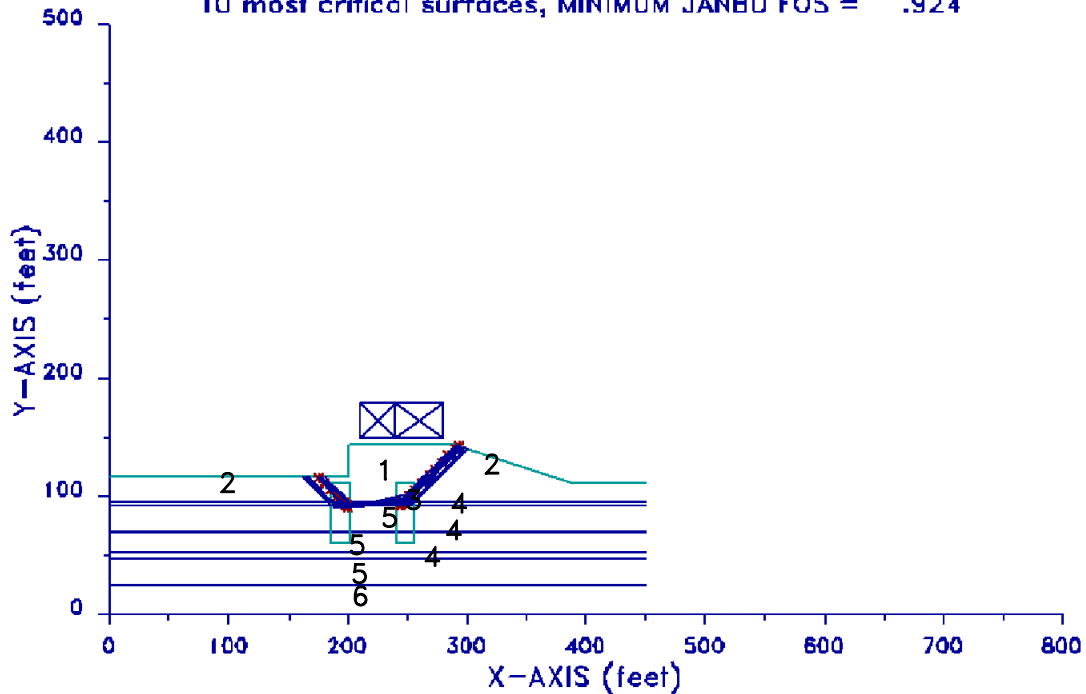
WB-01 Regular Profile STA 441+23  
 75% 0.26g (0.19g)  
 2500 YR-Short Period

Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125	850		0	Iso, Conven M-C
4	120	125		6	0	Iso, Conven M-C
5	120	125		30	0	Iso, Conven M-C
6	120	125		30	0	Iso, Conven M-C

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MSE STA441 0.19g B

10 most critical surfaces, MINIMUM JANBU FOS = .924



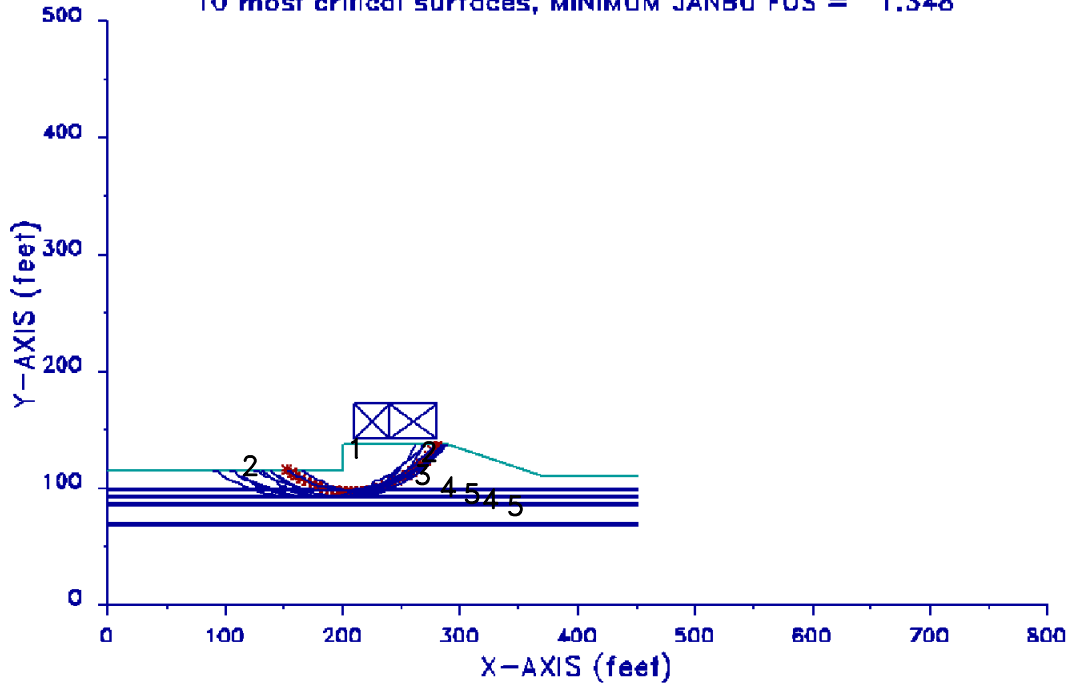
WB-01 Regular Profile STA 441+23  
 75% 0.26g (0.19g) Blocks  
 2500 YR-Short Period

Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125	850		0	Iso, Conven M-C
4	120	125		6	0	Iso, Conven M-C
5	120	125		30	0	Iso, Conven M-C
6	120	125		30	0	Iso, Conven M-C

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MSE STA443 0.20g

10 most critical surfaces, MINIMUM JANBU FOS = 1.348



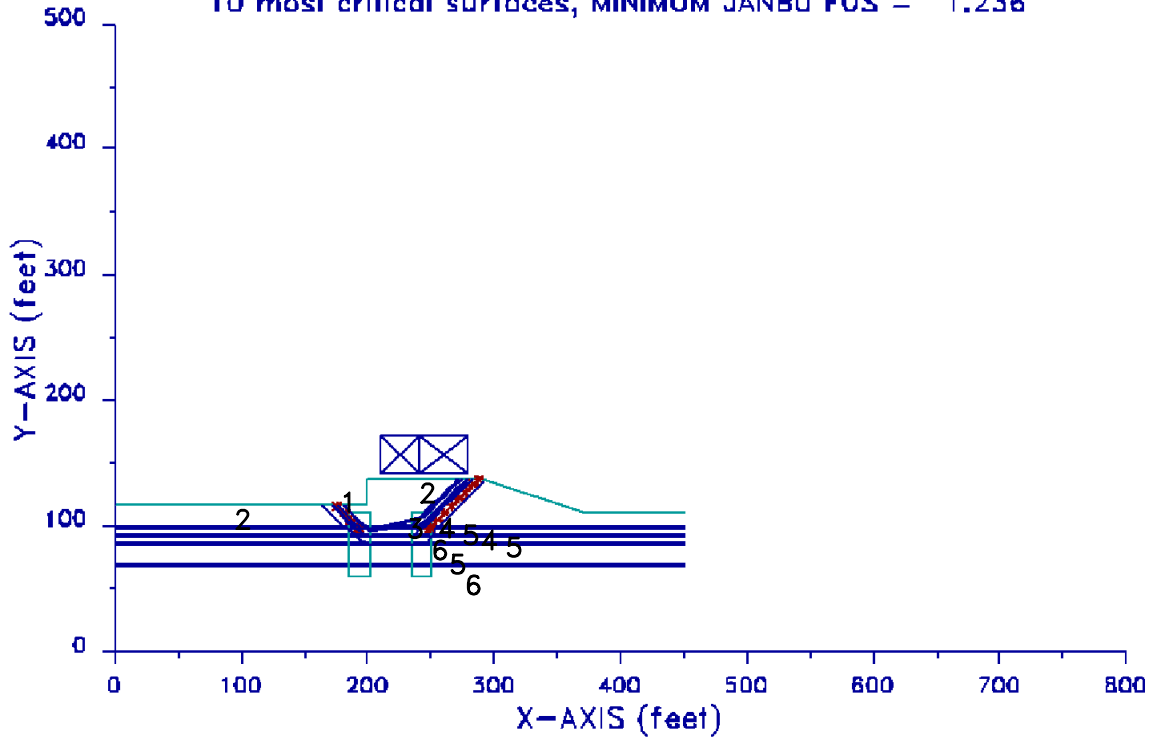
WB-06 Regular Profile STA 443+70  
 75% 0.27g (0.20)  
 2500 YR-Short Period

Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125	400		0	Iso, Conven M-C
4	120	125		28	0	Iso, Conven M-C
5	120	125		5	0	Iso, Conven M-C
6	120	125		30	0	Iso, Conven M-C

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MSE STA443 0.20g B

10 most critical surfaces, MINIMUM JANBU FOS = 1.236



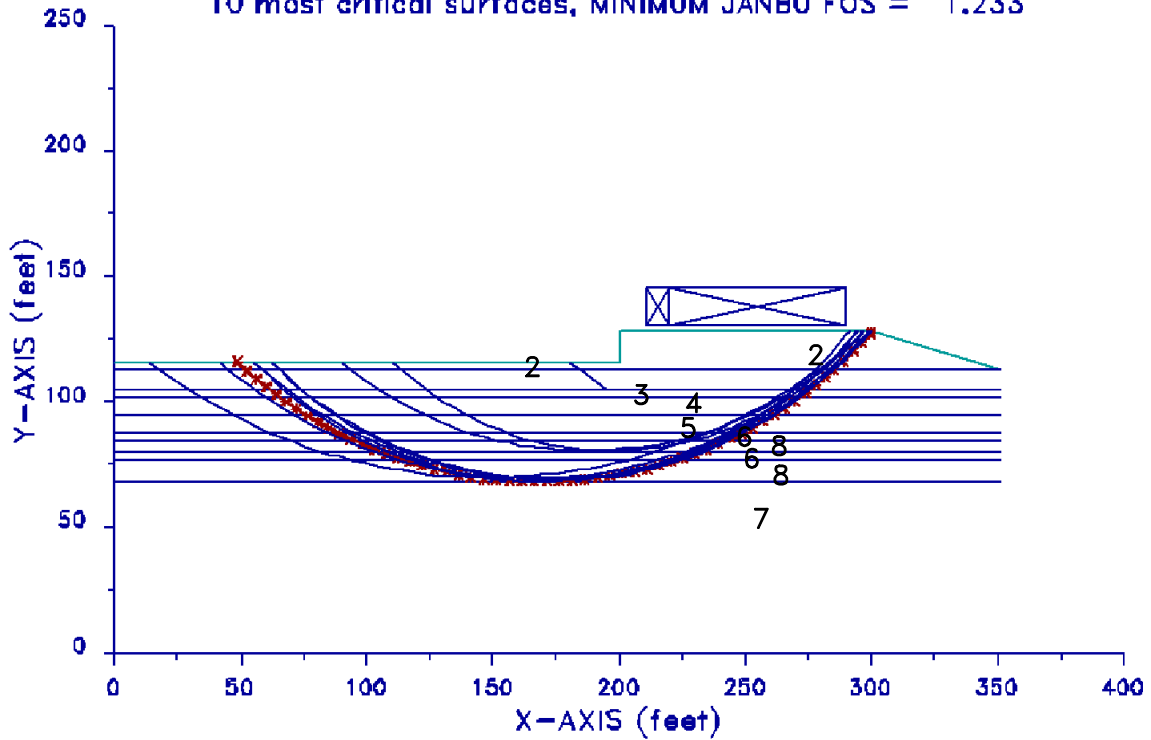
WB-06 Regular Profile STA 443+70  
 75% 0.27g (0.20) Block  
 2500 YR-Short Period

Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125	400		0	Iso, Conven M-C
4	120	125		28	0	Iso, Conven M-C
5	120	125		5	0	Iso, Conven M-C
6	120	125		30	0	Iso, Conven M-C

MSE Wall Slope Stability STA 443+70	 <b>Geo Services, Inc.</b> Geotechnical, Environmental & Civil Engineering 805 Amherst Court, Suite 204 Naperville, Illinois 60565 (630) 355-2838	DRAWN BY	AUB
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MSE STA447 0.20g

10 most critical surfaces, MINIMUM JANBU FOS = 1.233



WB-12 Regular Profile STA 447+50  
 75% 0.27g (0.20g)  
 2500 YR-Short Period

Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125		10	0	Iso, Conven M-C
4	120	125	2000		0	Iso, Conven M-C
5	120	125		28	0	Iso, Conven M-C
6	120	125	500		0	Iso, Conven M-C
7	120	125		36	0	Iso, Conven M-C
8	120	125		6	0	Iso, Conven M-C

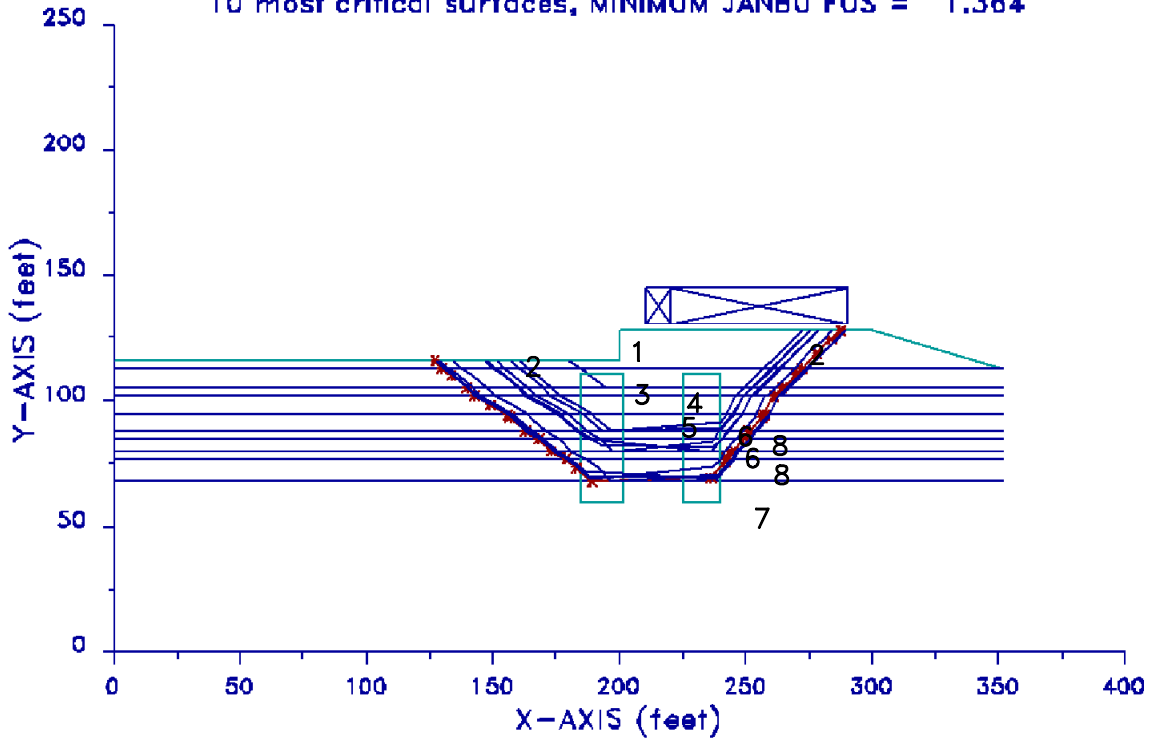
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 STRUCTURE GEOTECHNICAL REPORT for  
 FAI Route 70, Special Bulletin 890  
 I-70 Bridge Approach, Mississippi River  
 IDOT Job: D-93-059-08 (PTB 146, Item1)  
 St. Claire County, Illinois



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DATE	December 22, 2009
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MSE STA447 0.20g B

10 most critical surfaces, MINIMUM JANBU FOS = 1.364



WB-12 Regular Profile STA 447+50  
 75% 0.27g (0.20g) Block  
 2500 YR-Short Period

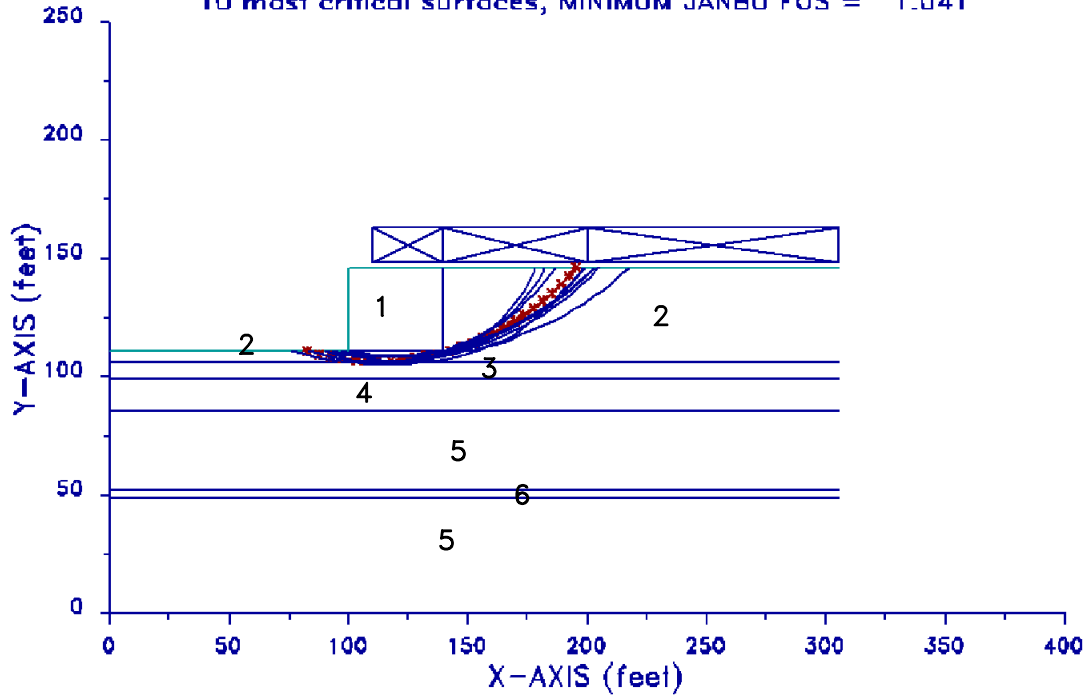
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	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125		10	0	Iso, Conven M-C
4	120	125	2000		0	Iso, Conven M-C
5	120	125		28	0	Iso, Conven M-C
6	120	125	500		0	Iso, Conven M-C
7	120	125		36	0	Iso, Conven M-C
8	120	125		6	0	Iso, Conven M-C

MSE Wall Slope Stability STA 447+50  
 STRUCTURE GEOTECHNICAL REPORT for  
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 IDOT Job: D-93-059-08 (PTB 146, Item1)  
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MSE STA439 0.14g  
 10 most critical surfaces, MINIMUM JANBU FOS = 1.041



SB-10 Liquefaction STA 439+50  
 75% 0.19g (0.14g)  
 1000 YR-Short Period

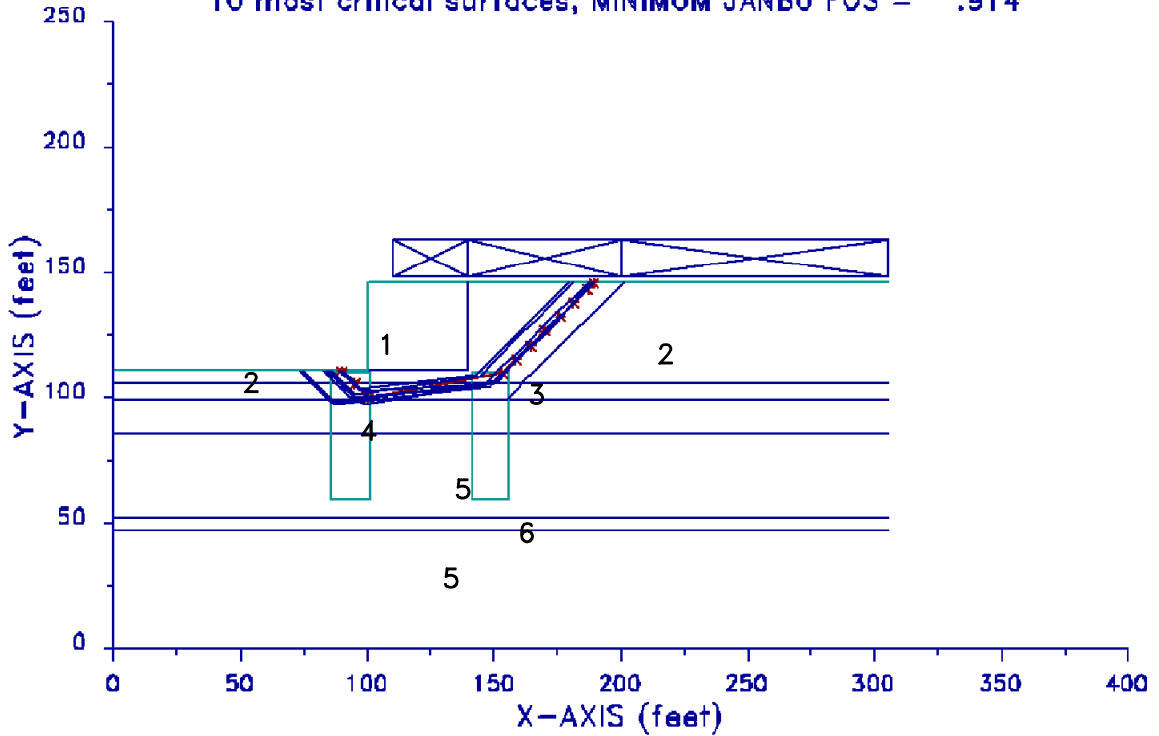
Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125	1250		0	Iso, Conven M-C
4	120	125		30	0	Iso, Conven M-C
5	120	125		32	0	Iso, Conven M-C
6	120	125		6	0	Iso, Conven M-C

MSE Wall Slope Stability STA 439+50	 <b>Geo Services, Inc.</b> Geotechnical, Environmental & Civil Engineering 805 Amherst Court, Suite 204 Naperville, Illinois 60565 (630) 355-2838	DRAWN BY	AUB
STRUCTURE GEOTECHNICAL REPORT for FAI Route 70, Special Bulletin 890 I-70 Bridge Approach, Mississippi River IDOT Job: D-93-059-08 (PTB 146, Item1) St. Claire County, Illinois		APPROVED BY	AJP
		DATE	December 22, 2009
		GSI JOB No.	08201



MSE STA439 0.14g B

10 most critical surfaces, MINIMUM JANBU FOS = .914

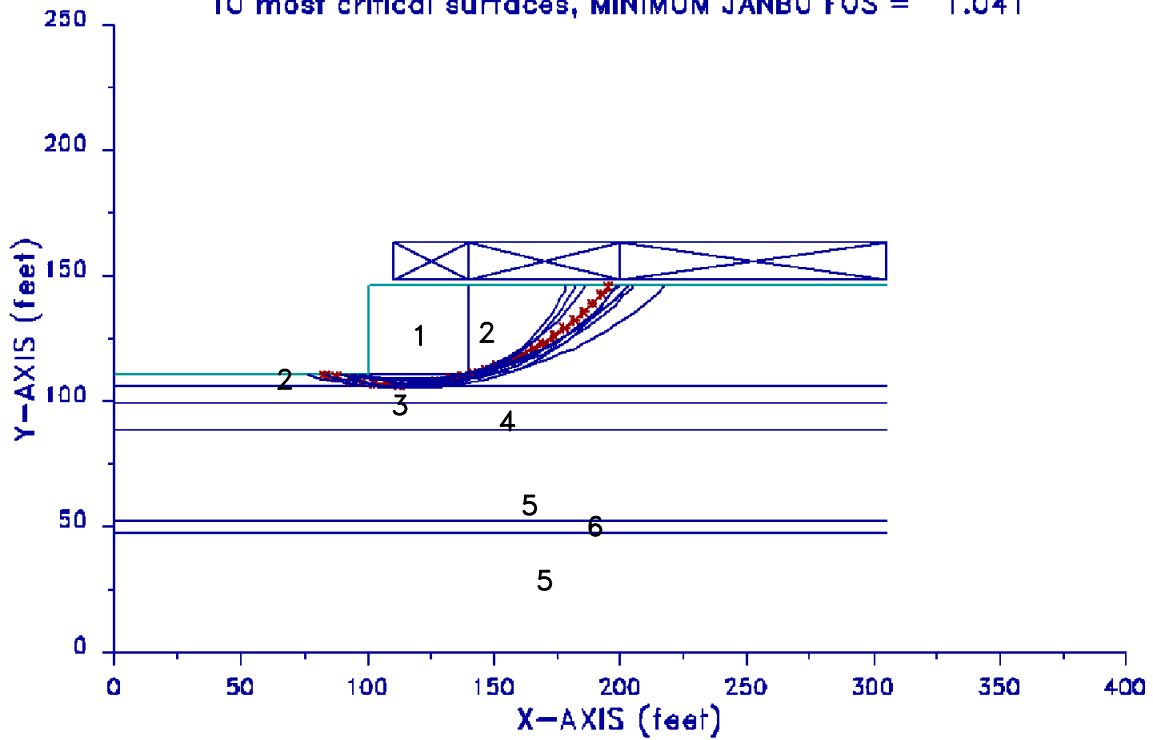


SB-10 Liquefaction STA 439+50  
 75% 0.19g (0.14g) Block  
 1000 YR-Short Period

Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125	1250		0	Iso, Conven M-C
4	120	125		30	0	Iso, Conven M-C
5	120	125		32	0	Iso, Conven M-C
6	120	125		6	0	Iso, Conven M-C

MSE Wall Slope Stability STA 439+50	 <b>Geo Services, Inc.</b> Geotechnical, Environmental & Civil Engineering 805 Amherst Court, Suite 204 Naperville, Illinois 60565 (630) 355-2838	DRAWN BY	AUB
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		DATE	December 22, 2009
		GSI JOB No.	08201

MSE STA440 0.14g  
 10 most critical surfaces, MINIMUM JANBU FOS = 1.041



SB-09 Regular Profile STA 440+23  
 75% 0.19g (0.14g)  
 1000 YR-Short Period

Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125	1250		0	Iso, Conven M-C
4	120	125		29	0	Iso, Conven M-C
5	120	125		32		
6	120	125		6	0	Iso, Conven M-C

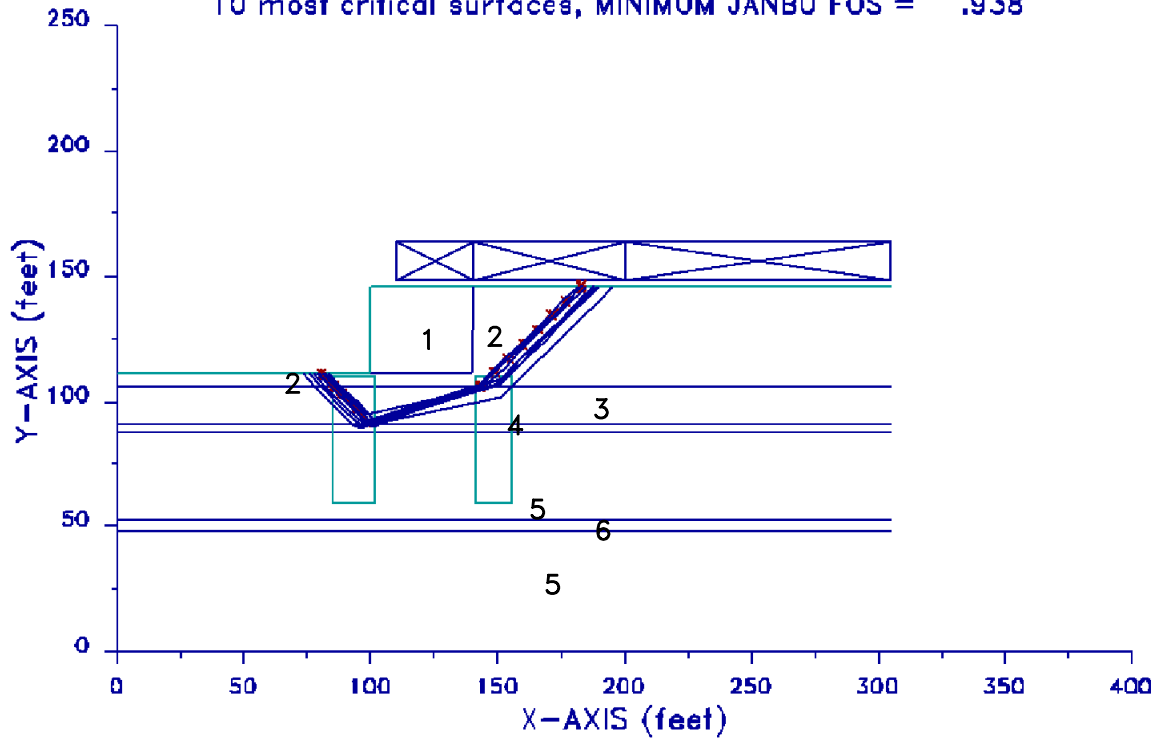
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 STRUCTURE GEOTECHNICAL REPORT for  
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MSE STA440 0.14g B

10 most critical surfaces, MINIMUM JANBU FOS = .938



SB-09 Regular Profile STA 440+23  
 75% 0.19g (0.14g) Block  
 1000 YR-Short Period

Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Saturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125	1250		0	Iso, Conven M-C
4	120	125		29	0	Iso, Conven M-C
5	120	125		32	0	Iso, Conven M-C
6	120	125		6	0	Iso, Conven M-C

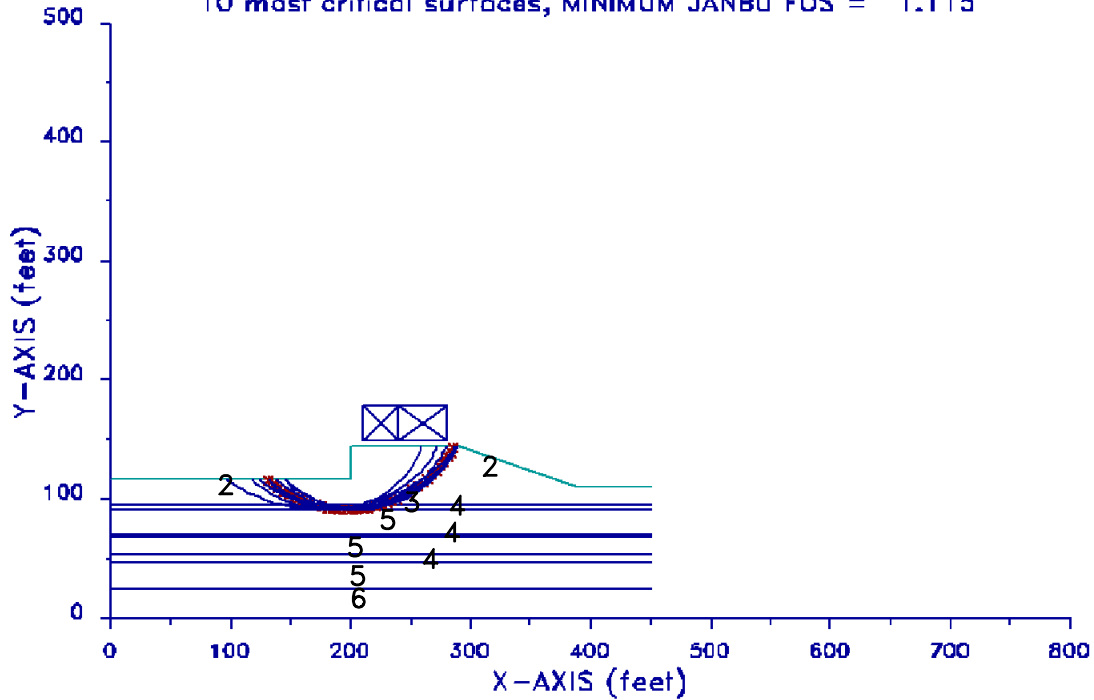
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 FAI Route 70, Special Bulletin 890  
 I-70 Bridge Approach, Mississippi River  
 IDOT Job: D-93-059-08 (PTB 146, Item1)  
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**MSE STA441 0.14g**

10 most critical surfaces, MINIMUM JANBU FOS = 1.115



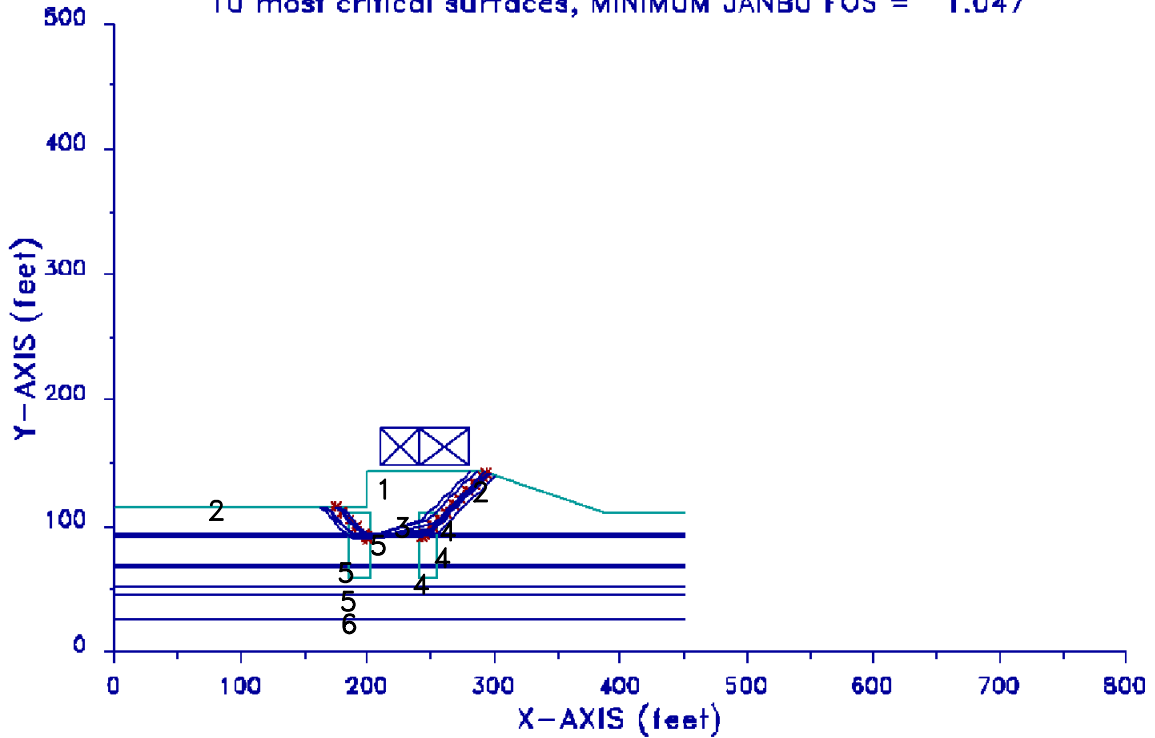
WB-01 Regular Profile STA 441+23  
 75% 0.19g (0.14g)  
 1000 YR-Short Period

Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125	850		0	Iso, Conven M-C
4	120	125		6	0	Iso, Conven M-C
5	120	125		30	0	Iso, Conven M-C
6	120	125		30	0	Iso, Conven M-C

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		DATE	December 22, 2009
		GSI JOB No.	08201

MSE STA441 0.14 B

10 most critical surfaces, MINIMUM JANBU FOS = 1.047



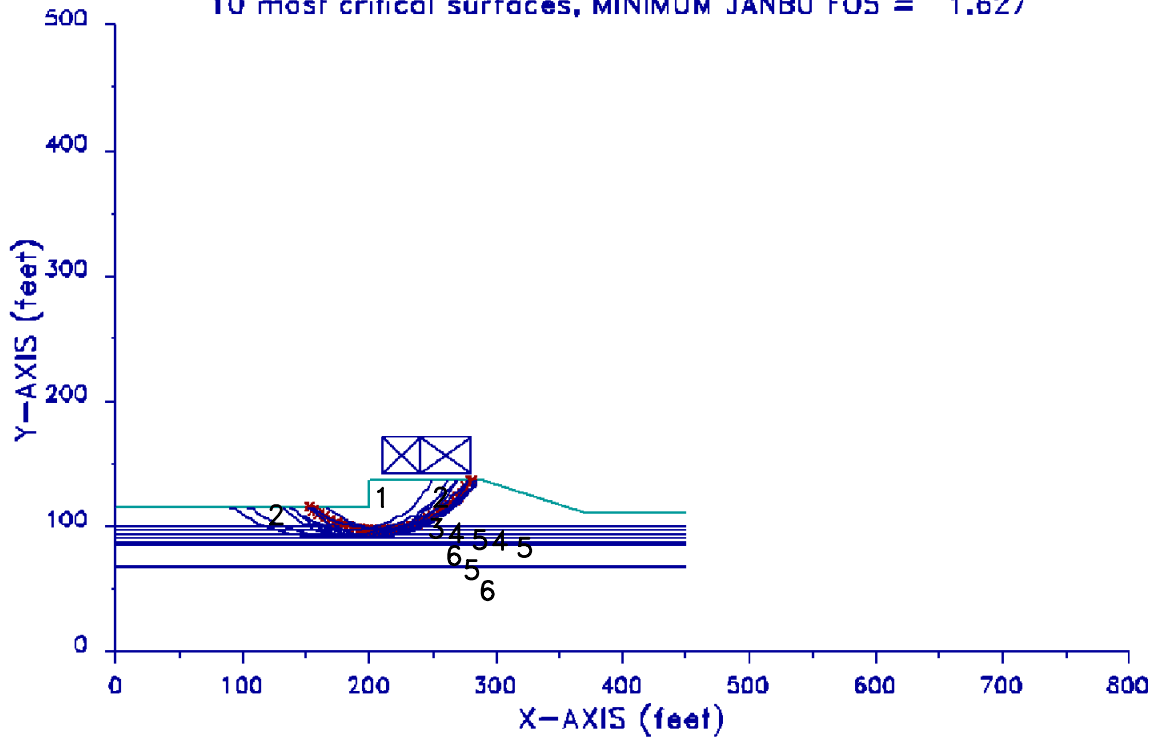
WB-01 Regular Profile STA 441+23  
 75% 0.19g (0.14g) Block  
 1000 YR-Short Period

Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125	850		0	Iso, Conven M-C
4	120	125		6	0	Iso, Conven M-C
5	120	125		30	0	Iso, Conven M-C
6	120	125		30	0	Iso, Conven M-C

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		GSI JOB No.	08201

MSE STA443 0.14g

10 most critical surfaces, MINIMUM JANBU FOS = 1.627



WB-06 Regular Profile STA 443+70  
 75% 0.19g (0.14)  
 1000 YR-Short Period

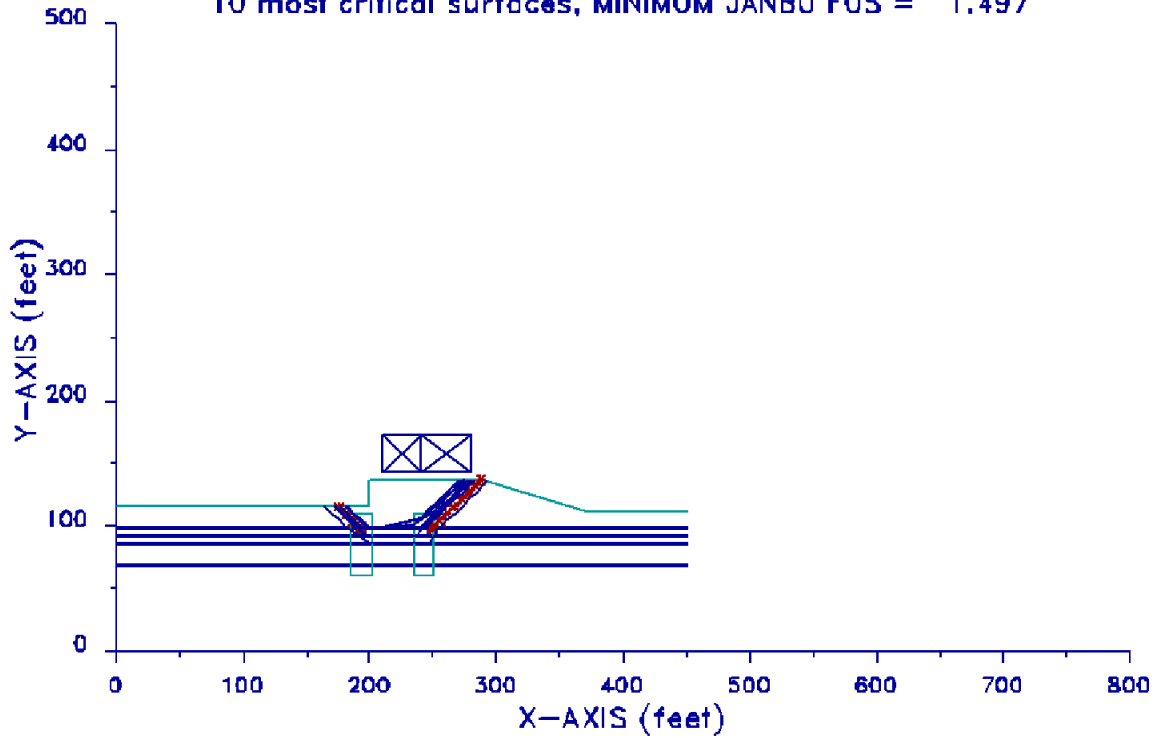
Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125	400		0	Iso, Conven M-C
4	120	125		28	0	Iso, Conven M-C
5	120	125		5	0	Iso, Conven M-C
6	120	125		30	0	Iso, Conven M-C

MSE Wall Slope Stability STA 443+70  
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 St. Claire County, Illinois



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GSI JOB No.	08201

MSE STA443 014g B  
 10 most critical surfaces, MINIMUM JANBU FOS = 1.497



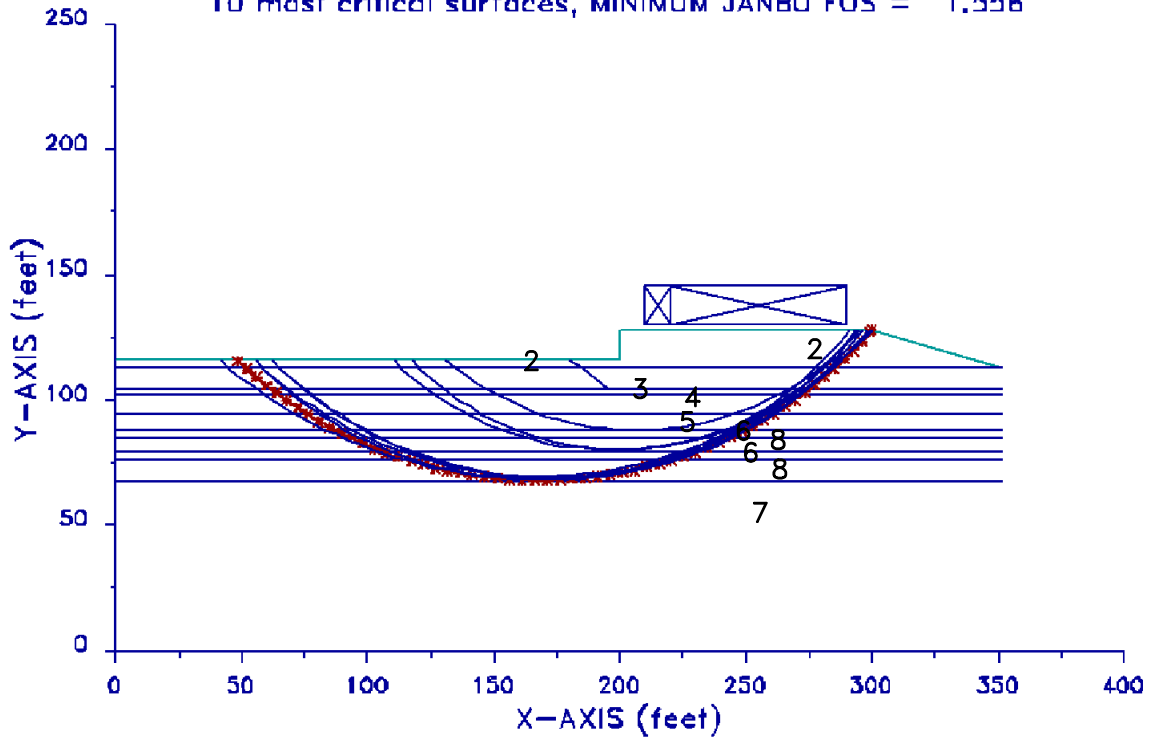
WB-06 Regular Profile STA 443+70  
 75% 0.19g (0.14) Block  
 1000 YR-Short Period

Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125	400		0	Iso, Conven M-C
4	120	125		28	0	Iso, Conven M-C
5	120	125		5	0	Iso, Conven M-C
6	120	125		30	0	Iso, Conven M-C

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		GSI JOB No.	08201

MSE STA447 0.14

10 most critical surfaces, MINIMUM JANBU FOS = 1.556



WB-12 Regular Profile STA 447+50  
 75% 0.19g (0.14g)  
 1000 YR-Short Period

Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125		10	0	Iso, Conven M-C
4	120	125	2000		0	Iso, Conven M-C
5	120	125		28	0	Iso, Conven M-C
6	120	125	500		0	Iso, Conven M-C
7	120	125		36	0	Iso, Conven M-C
8	120	125		6	0	Iso, Conven M-C

MSE Wall Slope Stability STA 447+50  
 STRUCTURE GEOTECHNICAL REPORT for  
 FAI Route 70, Special Bulletin 890  
 I-70 Bridge Approach, Mississippi River  
 IDOT Job: D-93-059-08 (PTB 146, Item1)  
 St. Claire County, Illinois

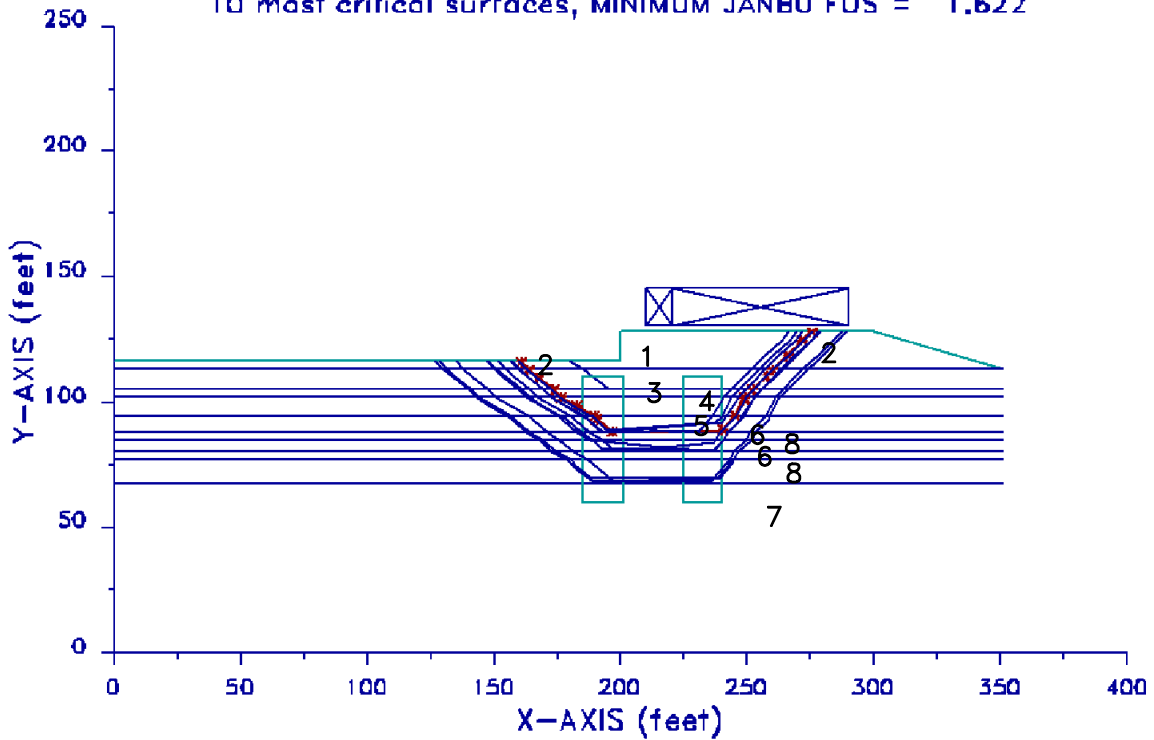


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MSE STA447 0.14g B

10 most critical surfaces, MINIMUM JANBU FOS = 1.622



WB-12 Regular Profile STA 447+50  
 75% 0.19g (0.14g) Block  
 1000 YR-Short Period

Soil Unit (#)	Unit Weight (pcf)		Strength		Water Sur Index	Type of Strength
	Moist	Sturated	c	phi		
1	120	125	2000		0	Iso, Conven M-C
2	120	125	1000		0	Iso, Conven M-C
3	120	125		10	0	Iso, Conven M-C
4	120	125	2000		0	Iso, Conven M-C
5	120	125		28	0	Iso, Conven M-C
6	120	125	500		0	Iso, Conven M-C
7	120	125		36	0	Iso, Conven M-C
8	120	125		6	0	Iso, Conven M-C

MSE Wall Slope Stability STA 447+50

STRUCTURE GEOTECHNICAL REPORT for  
 FAI Route 70, Special Bulletin 890  
 I-70 Bridge Approach, Mississippi River  
 IDOT Job: D-93-059-08 (PTB 146, Item1)  
 St. Claire County, Illinois



DRAWN BY	AUB
APPROVED BY	AJP
DATE	December 22, 2009
GSI JOB No.	08201

## **APPENDIX I**

# **GEOTECHNOLOGY SEISMIC REPORT**

**DOWNHOLE SEISMIC TESTING  
BOREHOLE WB-13  
I-70 PROJECT  
EAST ST. LOUIS, ILLINOIS**

*Prepared for:*

**GEO SERVICES, INC.  
ARLINGTON HEIGHTS, ILLINOIS**

*Prepared by:*

**GEOTECHNOLOGY, INC.  
St. Louis, Missouri**

Geotechnology, Inc. Report No. 1115001.95TS

October 9, 2009



VIA EMAIL: [drewptak@geoservices inc.net](mailto:drewptak@geoservices inc.net)

October 9, 2009

1115001.95TS

Mr. Drew Ptak, P.E.  
Geo Services, Inc.  
1235 East Davis Street  
Arlington Heights, Illinois 60005

Re: Downhole Seismic Testing  
Borehole WB-13  
I-70 Project  
East St. Louis, Illinois

Dear Mr. Ptak:

Presented herein are the results of a downhole seismic test for the referenced site. This work was conducted in general accordance with proposal P15835.00.95TS dated September 3, 2009. Presented in this report are descriptions of the geophysical method, data acquisition procedures and results.

It is a pleasure to be of service to you on this project. If you have any questions or comments, please contact the undersigned at (314) 997-7440.

Very truly yours,

**GEOTECHNOLOGY, INC.**

Boston Fodor  
Geophysicist

Douglas W. Lambert, R.G.  
Senior Project Manager-Geophysics

BGF/DWL:bgf/jsj

Copies Submitted: (3)

**DOWNHOLE SEISMIC TESTING**  
**BOREHOLE WB-13**  
**I-70 PROJECT**  
**EAST ST. LOUIS, ILLINOIS**

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**DOWNHOLE SEISMIC TESTING**  
**BOREHOLE WB-13**  
**I-70 PROJECT**  
**EAST ST. LOUIS, ILLINOIS**

**1.0 INTRODUCTION**

**1.1 Site Description.** The project is located near the intersection of Industrial Drive and St. Clair Avenue in East St. Louis, Illinois. A site location map is presented on Plate 1. Boring WB-13 was cased to an approximate depth of 132.5 feet. This project involved performing a downhole seismic test in Borehole WB-13 to estimate shear wave velocities of the subsurface materials.

**1.2 Scope of Work.** The scope of work included mobilizing geophysical equipment and personnel to the site, conducting downhole seismic tests, and processing/interpreting the data. Shear (S) and compressional (P) wave velocities were calculated and are presented in this report. Any engineering analysis or recommendations based on this data are outside our scope of work.

**2.0 GEOPHYSICAL SURVEY**

**2.1 Methodology.** The downhole survey was performed in general accordance with ASTM D7400 "Standard Test Methods for Downhole Seismic Testing". The downhole (surface-to-hole) seismic testing method involves generating shear and compressional wave seismic energy at the ground surface and recording the seismic waves at a geophone situated at various depths in an adjacent borehole. The seismic wave arrivals at the borehole geophone are digitally recorded using a seismograph. The data are interpreted by analyzing the one-way travel-times from the source to geophone. Average shear and compressional wave velocities can be calculated for each depth (between the surface and geophone) by analyzing the travel-time data. Interval velocities are calculated by comparing travel-time data recorded at the upper and lower limits of each depth interval.

**2.2 Data Acquisition.** Geotechnology performed downhole seismic tests to a depth of approximately 130 feet in Boring WB-13. The borehole geophone is a triaxial model that requires a clearance of approximately two feet from the bottom of the casing. Shear wave energy was generated by using a sledge hammer to strike each end (separately) of a wooden plank secured to the ground approximately 10 feet from the boring. Compressional wave energy was generated by using a sledge hammer to strike a horizontal metal plate situated approximately 12 feet from the boring. Shear and compressional wave data were recorded at 5-foot depth intervals within the boring.

### 3.0 RESULTS

Shear and compressional wave velocities were calculated using the recorded shear and compressional wave travel time and measured distances for each depth in the boring. The wave velocities and Poisson's ratio for each 5-foot depth interval were calculated using the following equations<sup>1</sup>:

$$\text{Slope travel distance from source to geophone (receiver) } L_R = (D^2 + X^2)^{0.5}$$

$$\text{Shear Wave Interval Velocity } V_S = (L_{R2} - L_{R1}) / T_{S(R2-R1)}$$

$$\text{Compressional Wave Interval Velocity } V_P = (L_{R2} - L_{R1}) / T_{P(R2-R1)}$$

$$\text{Poisson's ratio } (\sigma) = \frac{1 - 2(V_S / V_P)^2}{2 - 2(V_S / V_P)^2}$$

Where: D= vertical distance between source elevation and geophone elevation  
X= horizontal distance from center of energy source to geophone boring  
L<sub>R2</sub>= slope travel distance from source to geophone at top of interval  
L<sub>R1</sub>= slope travel distance from source to geophone at bottom of interval  
T<sub>S(R2-R1)</sub>= difference in shear wave travel time for geophones at top/bottom of interval  
T<sub>P(R2-R1)</sub>= difference in compressional wave travel time for geophones at top/bottom of interval

The calculated interval velocities for shear and compressional waves are plotted as average interval velocities between the measurement points in the subsurface. Shear and compressional wave interval velocities for Boring WB-13 are plotted on Plate 3 and listed with Poisson's ratios on Plate 4.

<sup>1</sup> Equations adapted from *Crosshole Seismic Survey* (Stokoe and Woods, 1972) and ASTM D4428 and D7400.



**NOTES**


Plan adapted from a 7.5 minute U.S.G.S. map for Granite City, Illinois Quadrangle, last revised in 1993.

0 2,000 4,000



SCALE IN FEET



Drawn By: SLC	Ck'd By: <i>SLC</i>	App'vd By: <i>[Signature]</i>
Date: 10-09-09	Date: <i>10-9-09</i>	Date: <i>10/9/09</i>
 <b>GEOTECHNOLOGY INC.</b> ENGINEERING AND ENVIRONMENTAL SERVICES ST. LOUIS • COLLINSVILLE • KANSAS CITY		
<b>Downhole Seismic Testing</b> <b>I-70 Project - WB - 13</b> <b>East St. Louis, Illinois</b>		
<b>SITE LOCATION</b> <b>AND TOPOGRAPHY</b>		
Project Number 1115001.95TS	<b>PLATE 1</b>	



**NOTES**

1. Plan adapted from an aerial photograph courtesy of Google Earth.
2. Boring was located in the field with reference to site features and is shown approximate only.


**LEGEND**

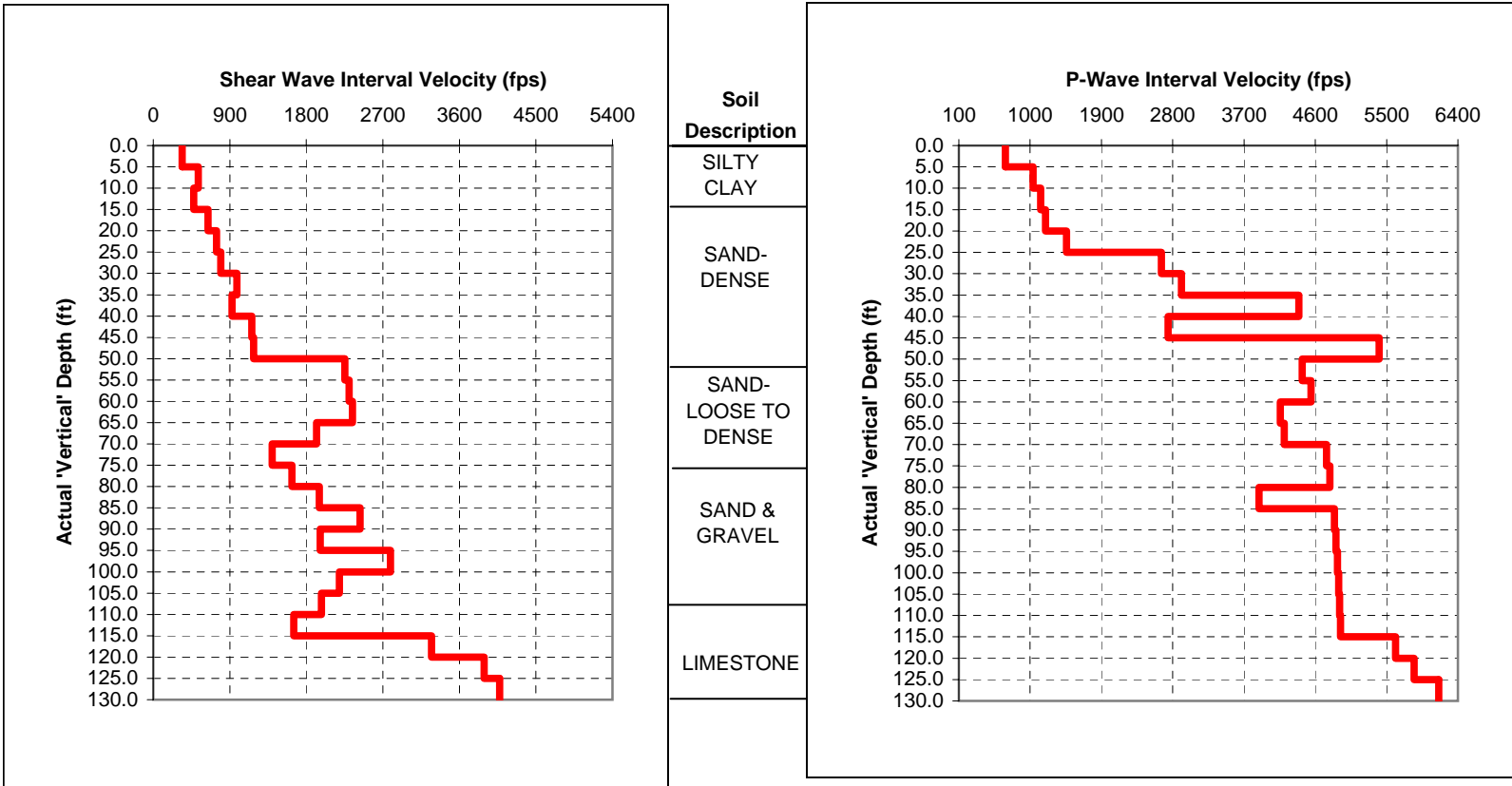
- Boring Location



SCALE IN FEET



Drawn By: SLC	Ckd By: BAF	App'vd By: DJJ
Date: 10-09-08	Date: 10-9-09	Date: 10/9/09
 <b>GEOTECHNOLOGY INC.</b> ENGINEERING AND ENVIRONMENTAL SERVICES ST. LOUIS • COLLINGSVILLE • KANSAS CITY		
Downhole Seismic Testing		
I-70 Project - WB - 13		
East St. Louis, Illinois		
<b>AERIAL PHOTOGRAPH OF SITE AND BORING LOCATION</b>		
Project Number	1116001.957S	
	<b>PLATE 2</b>	



**ADDENDUM  
 COMPRESSIONAL (P) AND SHEAR (S) WAVE VELOCITY VS DEPTH  
 BORING WB-13  
 TRI-LEVEL CONNECTOR  
 SAINT CLAIR, ILLINOIS**

<b>Summary Table:</b>		<b>I-70 Project</b>	
<b>Project No.:</b>		<b>1115001.95TS</b>	
<b>Boring:</b>		<b>WB-13 Addendum</b>	
<b>Depth (ft)</b>	<b>S-Velocity (ft/sec)</b>	<b>P-Velocity (ft/sec)</b>	<b>Poisson's Ratio</b>
5	338.80	688.74	0.34
10	530.50	1036.51	0.32
15	475.58	1133.18	0.39
20	641.95	1192.99	0.30
25	743.61	1458.27	0.32
30	795.08	2657.31	0.45
35	984.63	2908.89	0.44
40	927.01	4392.51	0.48
45	1158.54	2742.07	0.39
50	1179.62	5407.58	0.48
55	2254.57	4434.82	0.33
60	2304.51	4545.43	0.33
65	2341.96	4156.43	0.27
70	1919.94	4206.53	0.37
75	1397.69	4742.64	0.45
80	1629.07	4782.86	0.43
85	1951.38	3888.14	0.33
90	2431.53	4839.81	0.33
95	1964.14	4861.24	0.40
100	2787.96	4878.92	0.26
105	2187.63	4893.64	0.38
110	1976.05	4906.00	0.40
115	1652.88	4916.45	0.44
120	3273.06	5613.08	0.24
125	3889.95	5846.14	0.10
130	4072.24	6157.73	0.11

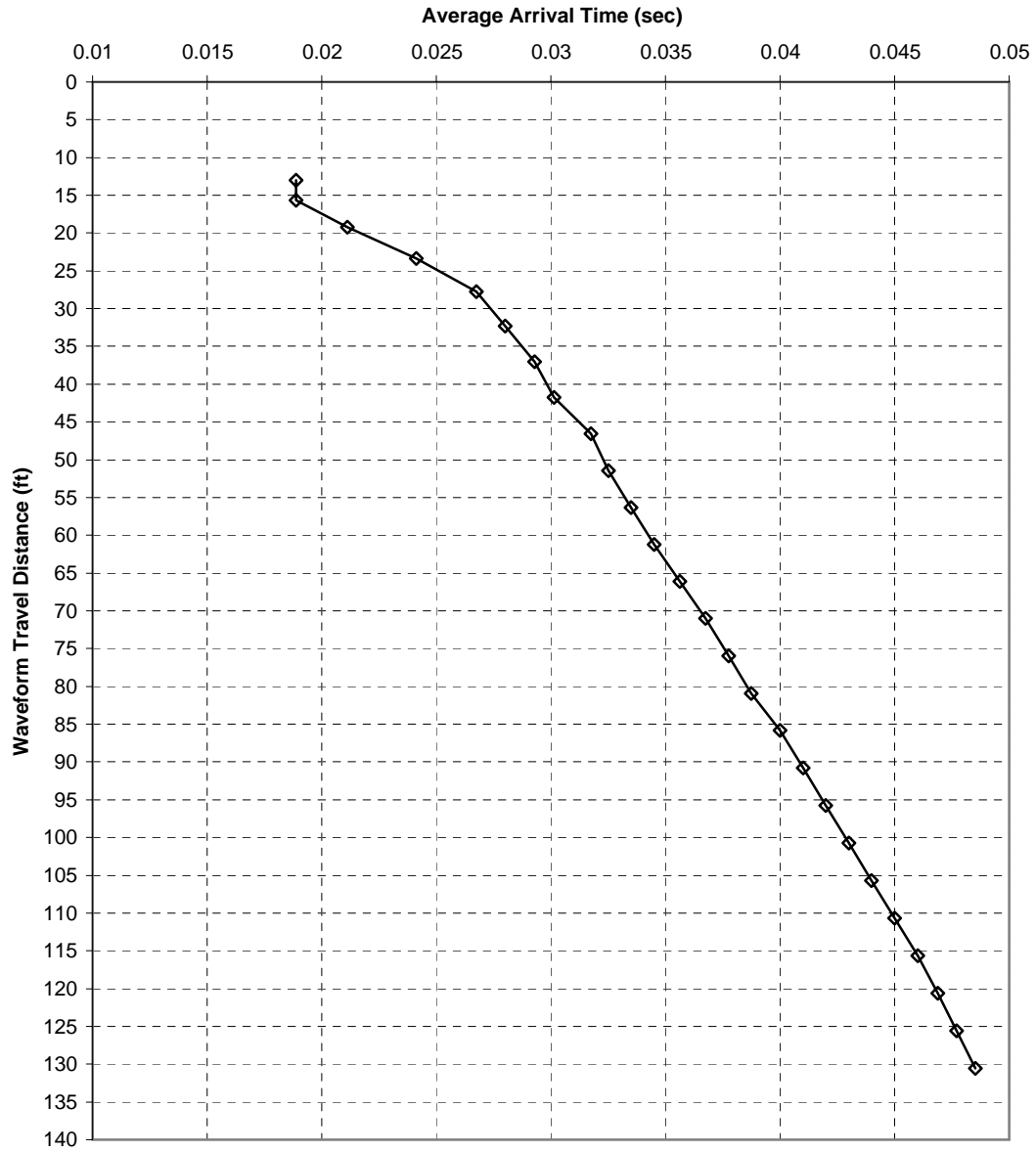
**APPENDIX A**

**LIMITATIONS OF REPORT**

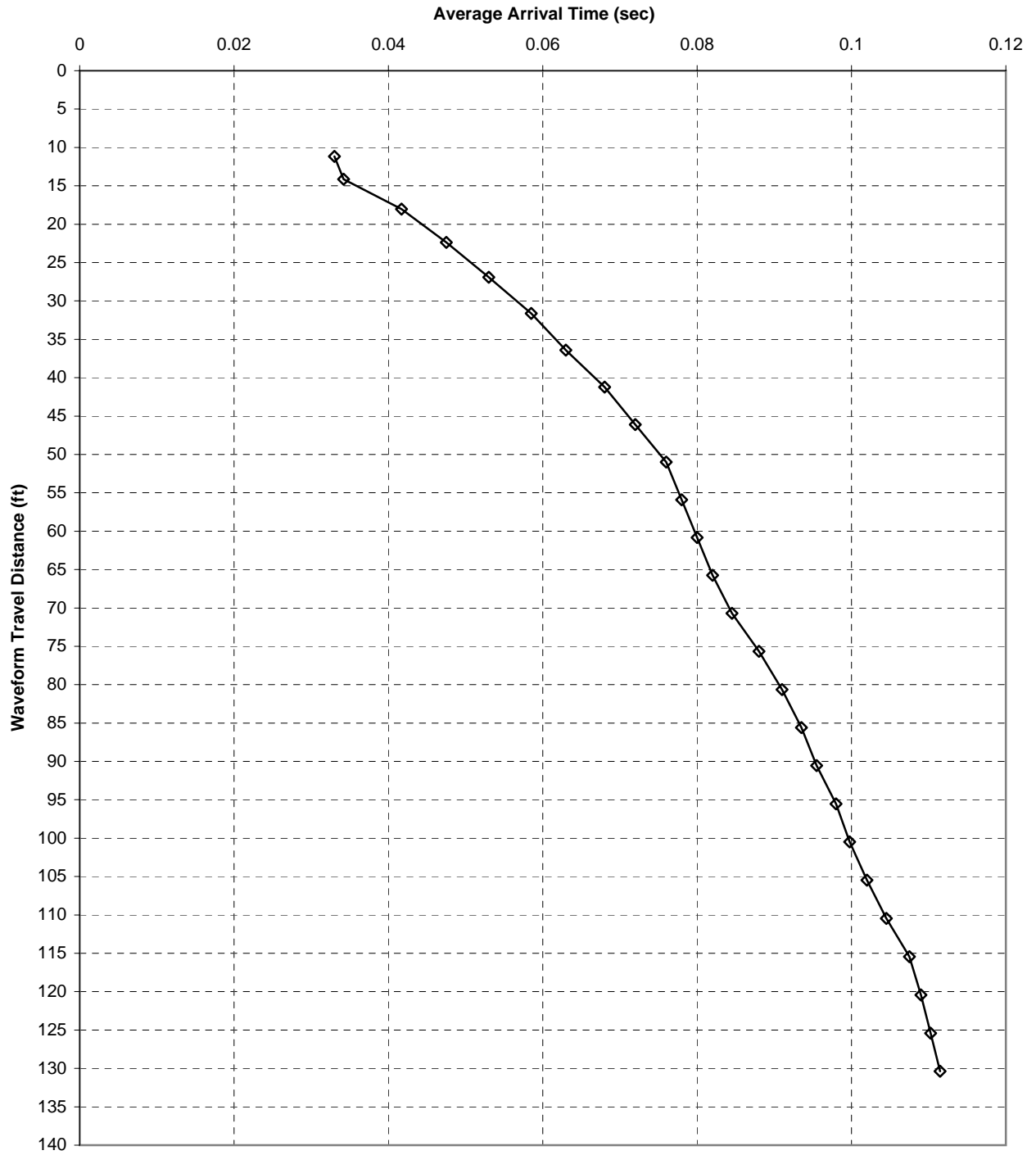
**GEOPHYSICAL SERVICES**  
**LIMITATIONS OF REPORT**

1. This report was prepared for the exclusive use of the owner, architect, and engineer for evaluating the project as it relates to the technical aspects discussed herein. It can be made available to prospective contractors for information on factual data only and not as a warranty of subsurface conditions included in this report. Unless other contractual agreements were made, the services described in this report were carried out in accordance with the Terms for Geotechnology's Services which were attached to the proposal.
2. Geotechnology endeavored to perform the downhole seismic geophysical survey in accordance with generally accepted practices of other consultants undertaking similar studies at the same time and in the same geographical area. The findings and conclusions stated herein must be considered not as scientific certainties, but rather as professional opinions concerning the significance of the limited data gathered during the course of the survey. No warranty, express or implied, is made.
3. The geophysical analyses and conclusions contained in this report are based on the site conditions, project layout, sampling interval, geophysical data, and interpretive procedures described herein. Geotechnology can make no interpretation of underground conditions beyond the test location. Geophysical exploration methods are indirect and potentially influenced by a variety of natural or man-made conditions. The resulting interpretations are based on the quality of the recorded data as limited by site conditions

### WAVEFORM TRAVEL DISTANCE VS. AVERAGE ARRIVAL TIME P-WAVE (WB-13)



**WAVEFORM TRAVEL DISTANCE VS. AVERAGE ARRIVAL TIME  
S-WAVE (WB-13)**



## **APPENDIX J**

### **SITE SPECIFIC GROUND AMPLIFICATION**



**Scott M. Olson, Ph.D., P.E.**  
**Geotechnical Engineer**  
300 E. Tomaras Ave., Savoy, Illinois 61874

**INTERIM RESULTS MEMORANDUM**

To: Mr. Drew Ptak  
GeoServices, Inc.  
From: Scott Olson  
Date: November 19, 2009  
RE: Interim site response analysis results for Darling Spur area  
I-70 Connector project

This memorandum provides interim site response results for the Darling Spur area. A complete description of the seismic soil characterization, site response analyses, and site response interpretation will be provided in a forthcoming report for the project.

To account for differences in the subsurface profile (namely, the thickness of the surficial recent overbank deposits), I separated the project reach into two representative soil columns. The results from the first soil column, termed MSE\_1, apply to the reach from about Sta. 139+80 to Sta. 143+40. The results from the second soil column, termed MSE\_2, apply to the reach from about Sta. 143+40 to 147+60. In terms of corresponding borings, MSE\_1 applies to borings WB-01 through WB-05, while MSE\_2 applies to borings WB-06 through WB-12. This information is summarized in the table below.

Soil column designation	Approx. project reach	Corresponding borings
MSE_1	Sta. 139+80 to Sta. 143+40	WB-01 to WB-05
MSE_2	Sta. 143+40 to Sta. 147+60	WB-06 to WB-12

Figures 1 through 8 below provide the results of the site response analyses for the two soil columns. The table below summarizes the key information required for liquefaction analysis, earthquake magnitude (M) and surface peak ground acceleration (pga).

Soil column	Probability of exceeding	CMS period (s)	M	R (km)	Surface pga (g)	Figure
MSE_1	5% in 50 years	0.2	5.6	20	0.19	1
		1.0	7.5	200	0.10	2
	2% in 50 years	0.2	6.0	15	0.27	3
		1.0	7.7	200	0.11	4
MSE_2	5% in 50 years	0.2	5.6	20	0.19	5
		1.0	7.5	200	0.10	6
	2% in 50 years	0.2	6.0	15	0.26	7
		1.0	7.7	200	0.12	8

Figure 1. Site response results; Soil column MSE\_1; 5% PE in 50 years; CMS T = 0.2s

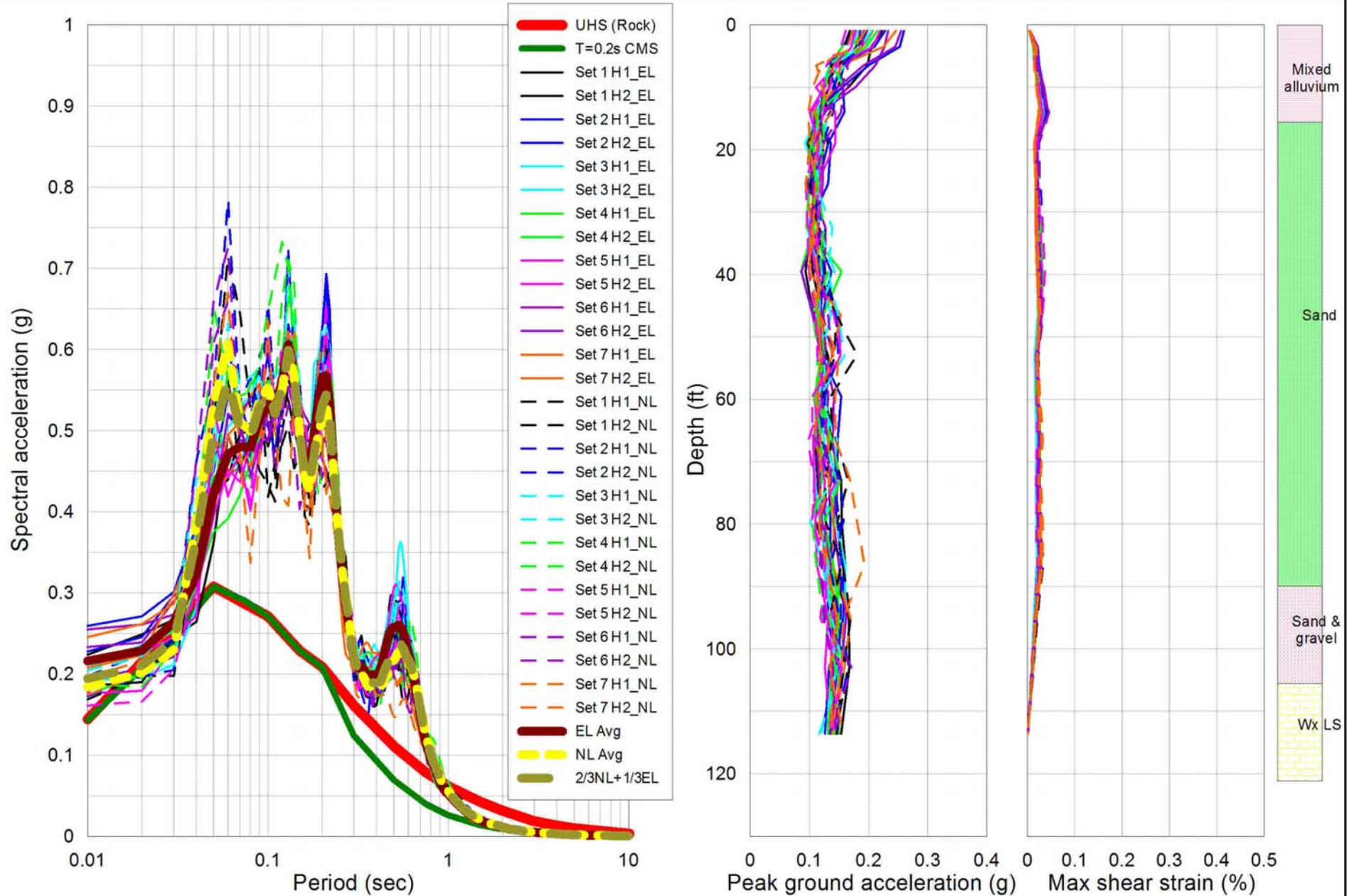


Figure 2. Site response results; Soil column MSE\_1; 5% PE in 50 years; CMS T = 1.0s

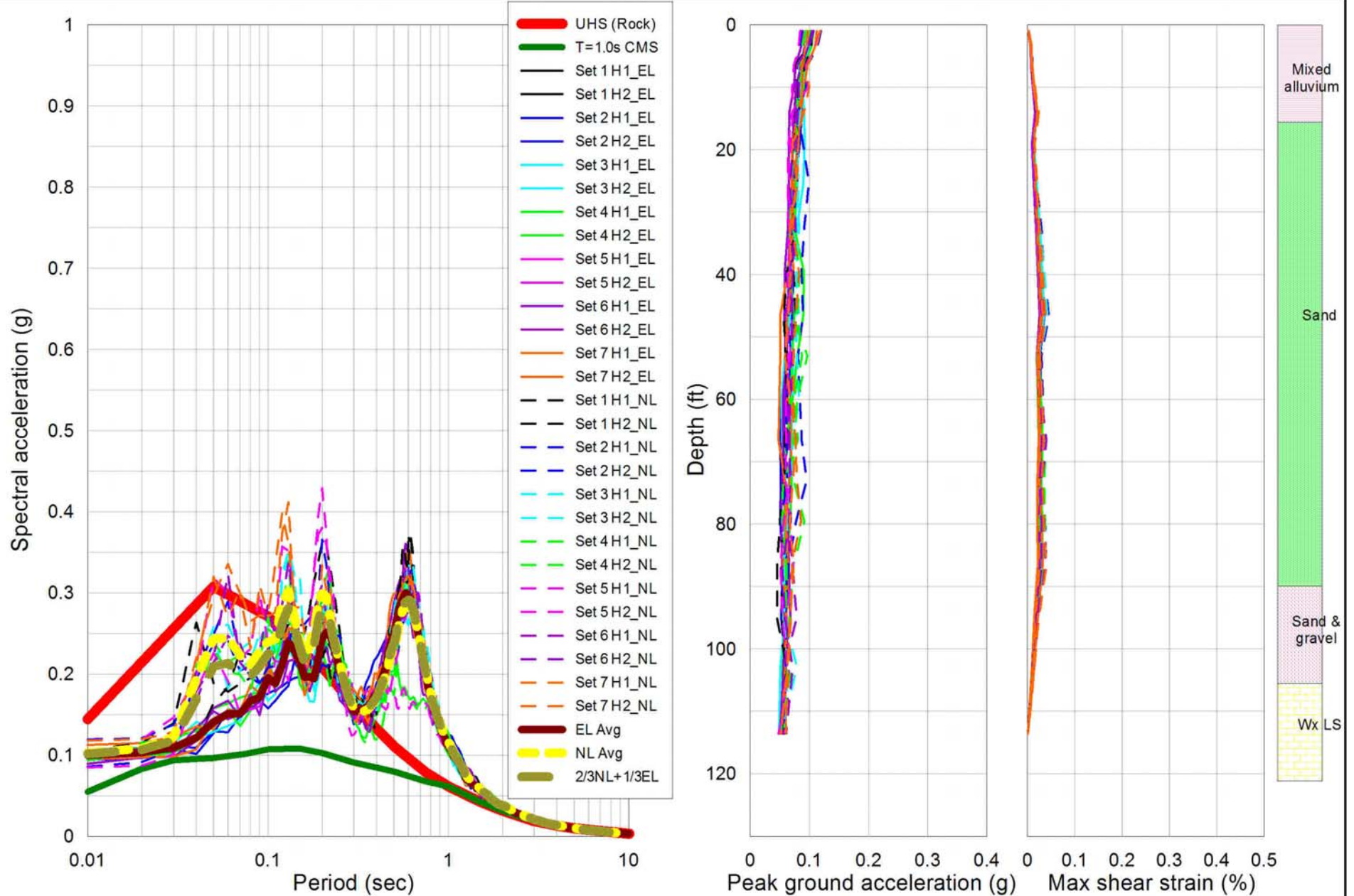


Figure 3. Site response results; Soil column MSE\_1; 2% PE in 50 years; CMS T = 0.2s

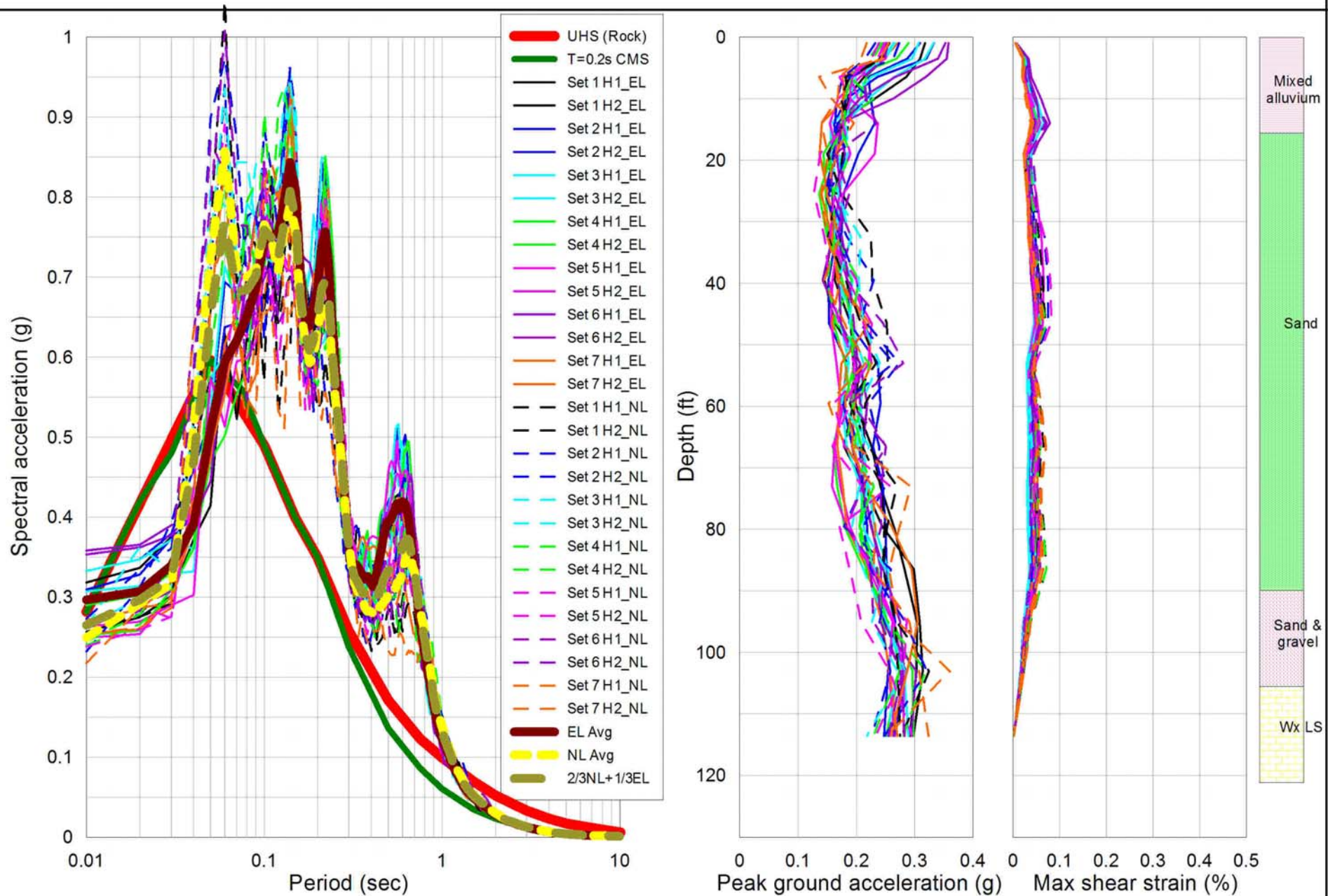


Figure 4. Site response results; Soil column MSE\_1; 2% PE in 50 years; CMS T = 1.0s

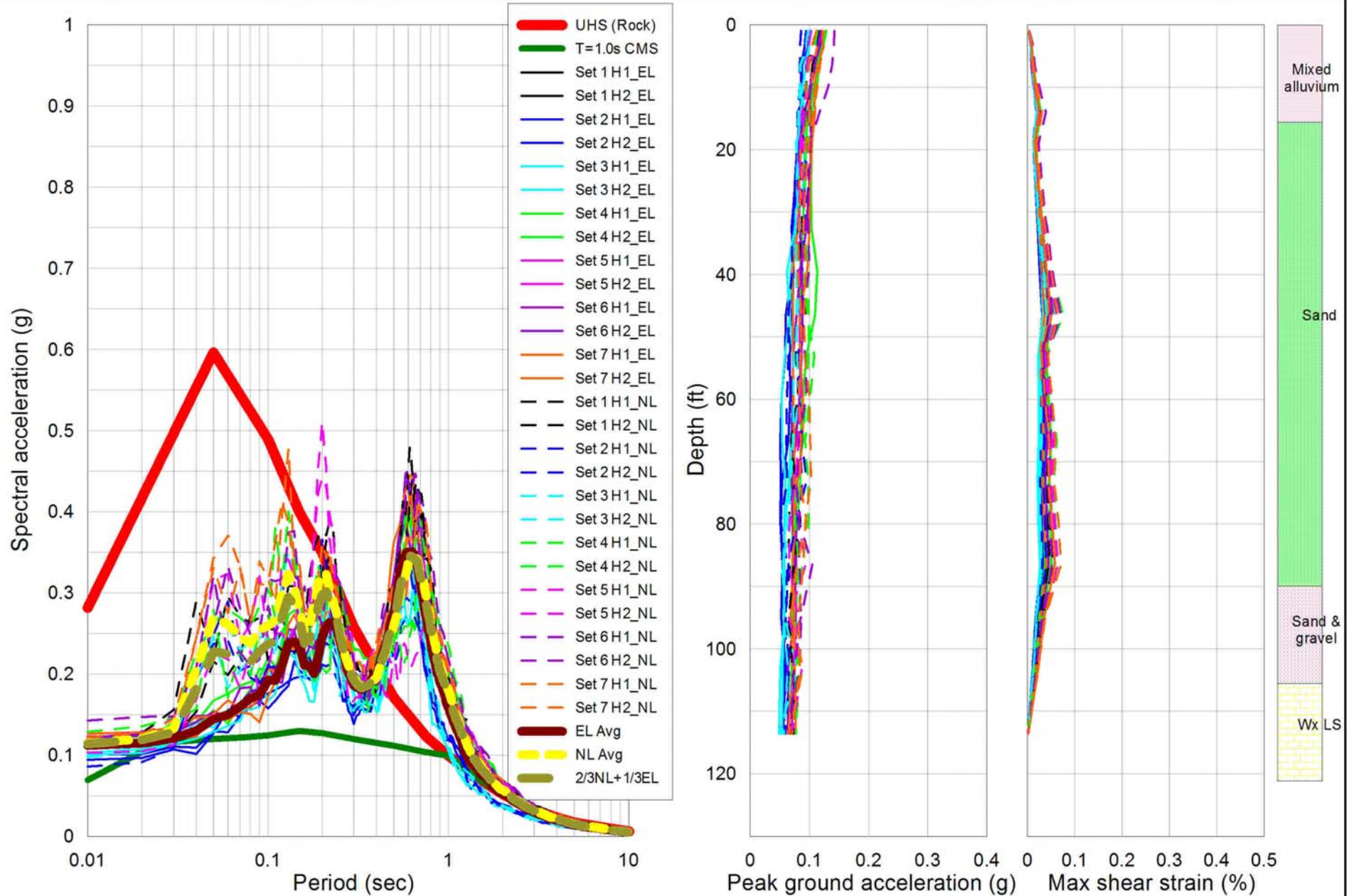


Figure 5. Site response results; Soil column MSE\_2; 5% PE in 50 years; CMS T = 0.2s

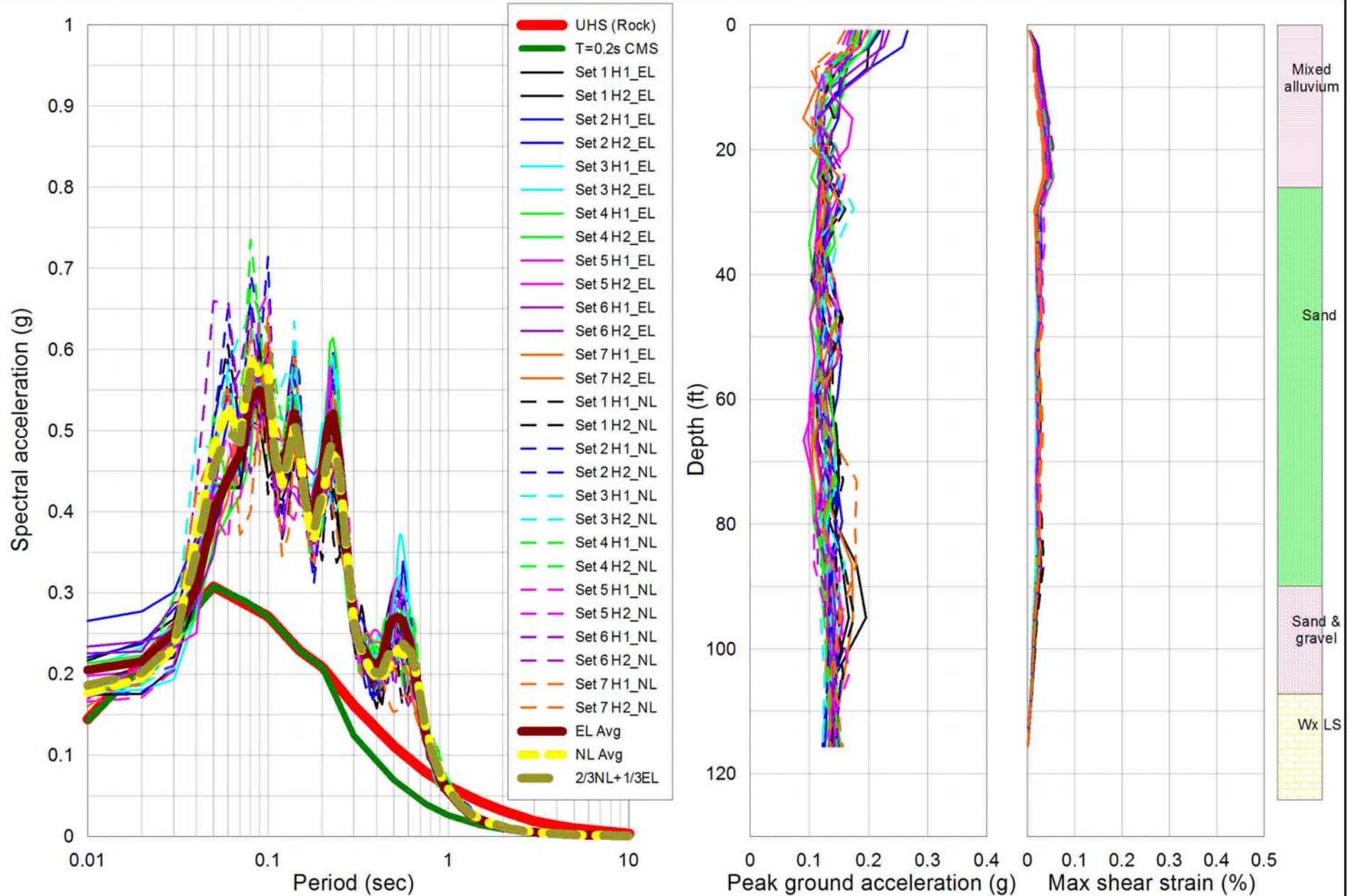


Figure 6. Site response results; Soil column MSE\_2; 5% PE in 50 years; CMS T = 1.0s

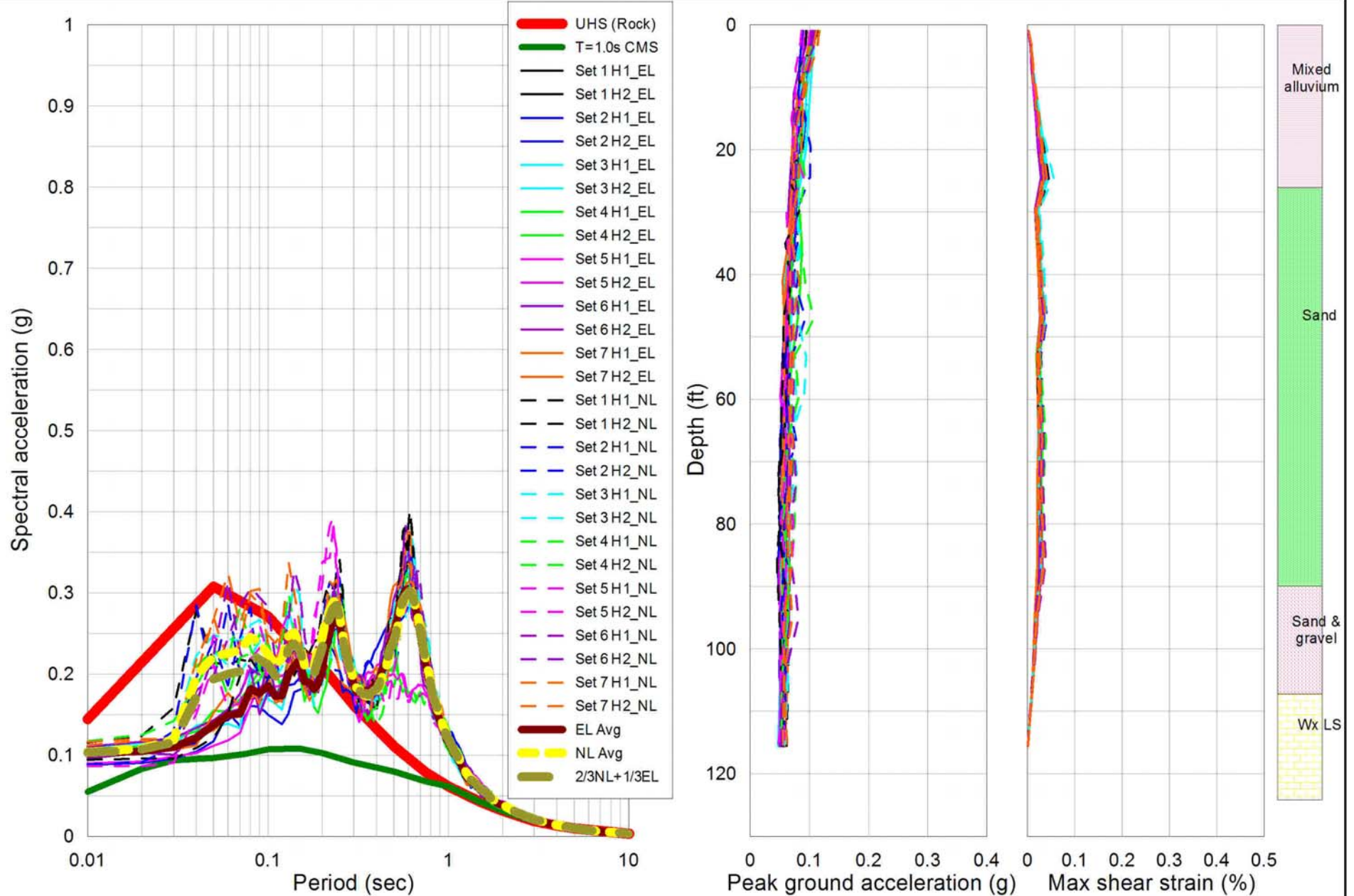


Figure 7. Site response results; Soil column MSE\_2; 2% PE in 50 years; CMS T = 0.2s

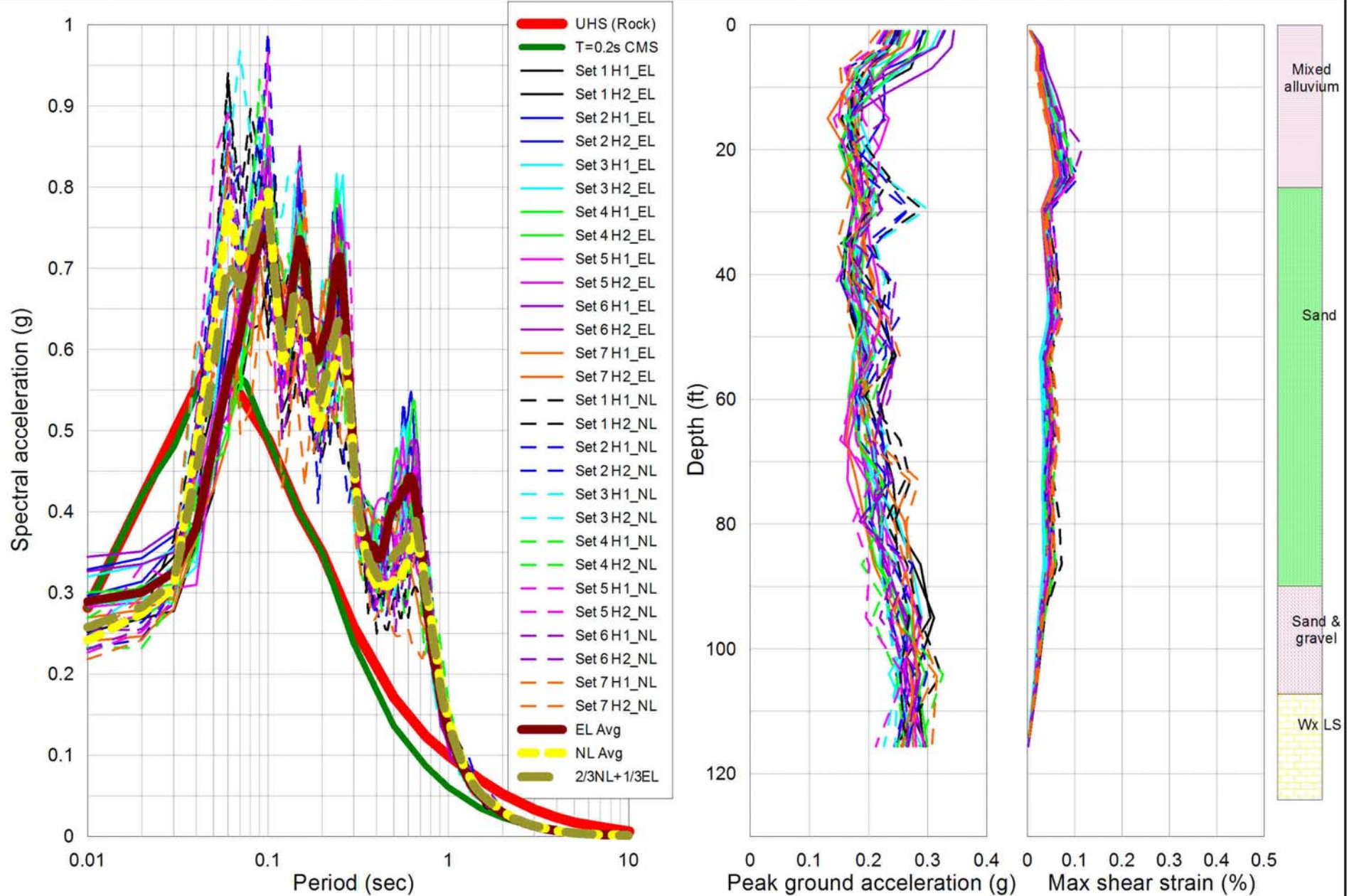
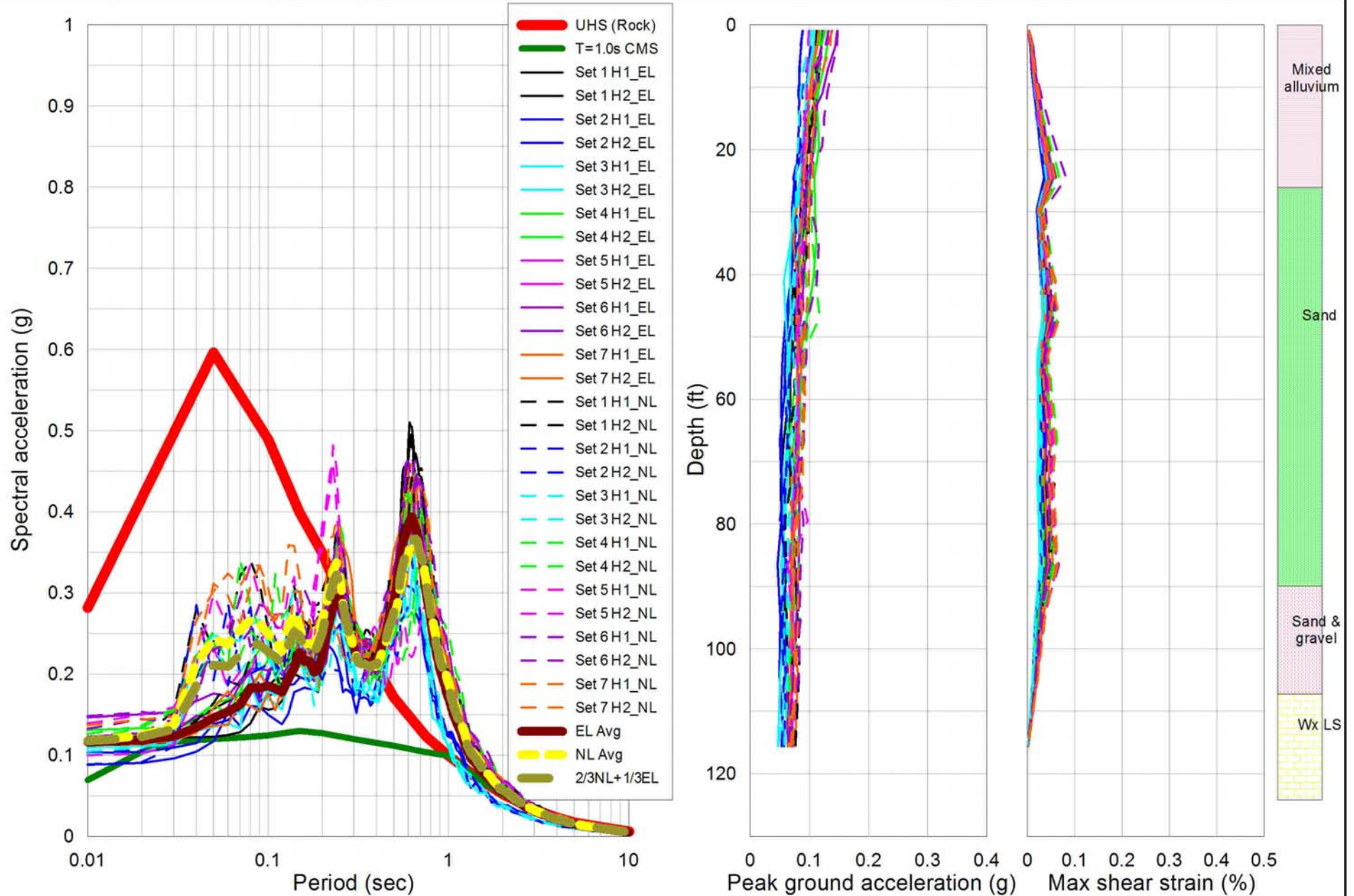
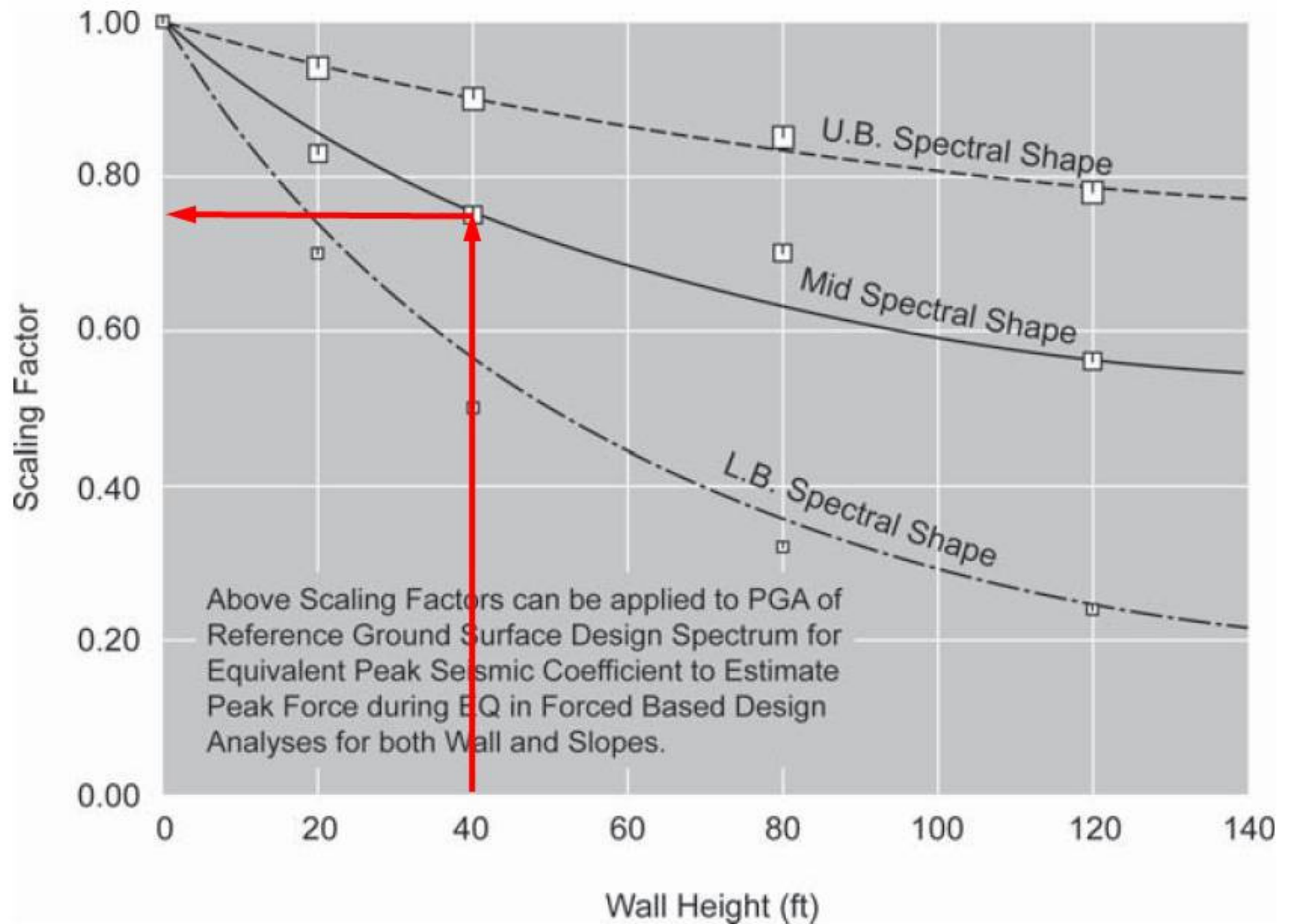




Figure 8. Site response results; Soil column MSE\_2; 2% PE in 50 years; CMS T = 1.0s



**APPENDIX K**  
**NCHRP CHART**



NCHRP Report 611. (2008). Seismic analysis and design of retaining walls, buried structures, slopes, and embankments