

**Report of CCR Rule Stability
Analyses
AEP Clifty Creek Power Plant
Boiler Slag Pond Dam and
Landfill Runoff Collection Pond**

Madison, Jefferson County,
Indiana



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**REPORT OF CCR RULE STABILITY ANALYSES
AEP CLIFTY CREEK POWER PLANT
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Executive Summary

The Clifty Creek Power Station's Boiler Slag Pond Dam, owned and operated by the Indiana and Kentucky Electric Corporation (IKEC), is located in the city of Madison, Indiana along the northern bank of the Ohio River. The Boiler Slag Pond currently serves as a settling facility for sluiced bottom ash produced at the plant. In addition to the process flows from the plant, approximately 510 acres drain to the facility. The pond is formed by natural grade to the north, east, and west; as well as a southern dike that runs along the bank of the Ohio River.

The Landfill Runoff Collection Pond serves as a collection pond for the Coal Combustion Byproducts Landfill. The pond is formed by natural grades to the north, east, and west; as well as a southern dam that runs along the bank of the Ohio River. The drainage area of the pond is approximately 443 acres. The Indiana Department of Natural Resources (IDNR) has designated this dam as No. 39-12, which was registered as a High Hazard Structure in 2010.

Stantec Consulting Services Inc. (Stantec) was contracted to perform a geotechnical exploration, stability analysis, and liquefaction assessment of the dike for these facilities in 2009 (Landfill Runoff Collection Pond) and in 2010 (Boiler Slag Pond Dam). The intent of the explorations was to develop subsurface data at cross-sections along the dike for the Boiler Slag Pond and the dam for the Landfill Collection Runoff Pond and to perform conventional seepage and stability analyses, assessing the performance of the facilities. The potential for liquefaction was to be evaluated according to simplified published methods. Reports from past geotechnical explorations were used to supplement subsurface data.

In response to the Coal Combustion Residual (CCR) rules mandated in the Federal Register on April 17, 2015, AEP contracted Stantec to perform stability analyses for the Boiler Slag Pond Dam and Landfill Runoff Collection Pond to estimate static, seismic, and liquefaction potential factors of safety. According to Section 257.73(e)(1)(i) through (iv), the factor of safety assessment CCR rules are:

- (i) The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.
- (ii) The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.
- (iii) The calculated seismic factor of safety must equal or exceed 1.00
- (iv) For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

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The factors of safety obtained during the analyses for static and seismic load cases were greater than those required for Section 257.73 (e)(1)(i) through (iii). The average factor of safety for each soil horizon that was susceptible to liquefaction was greater than that required in Section 257.74 (e)(1)(iv).

The results of the 2010 analyses can be found in Section 6.1.1 for the Boiler Slag Pond Dam and Section 6.1.2 for the Landfill Runoff Collection Pond. The results of the 2015 CCR review can be found in Section 6.1.2 for the Boiler Slag Pond Dam and Section 6.2.2 for the Landfill Runoff Collection Pond.

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1.0 INTRODUCTION

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The Landfill Runoff Collection Pond serves as a collection pond for the Coal Combustion Byproducts Landfill. The pond is formed by natural grades to the north, east, and west; as well as a southern dam that runs along the bank of the Ohio River. The drainage area of the pond is approximately 443 acres. The Indiana Department of Natural Resources (IDNR) has designated this dam as No. 39-12, which was registered as a High Hazard Structure in 2010.

Stantec Consulting Services Inc. (Stantec) was contracted to perform a geotechnical exploration, stability analysis, and liquefaction assessment of the dike for these facilities in 2009 (Landfill Runoff Collection Pond) and in 2010 (Boiler Slag Pond Dam). The intent of the explorations was to develop subsurface data at cross-sections along the dike for the Boiler Slag Pond and the dam for the Landfill Collection Runoff Pond and to perform conventional seepage and stability analyses, assessing the performance of the facilities. The potential for liquefaction was to be evaluated according to simplified published methods. Reports from past geotechnical explorations were used to supplement subsurface data.

In response to the Coal Combustion Residual (CCR) rules mandated in the Federal Register on April 17, 2015, AEP contracted Stantec to perform stability analyses for the Boiler Slag Pond Dam and Landfill Runoff Collection Pond to estimate static, seismic, and liquefaction potential factors of safety. According to Section 257.73(e)(1)(i) through (iv) of the CCR rules, the required factors of safety are as follows:

- (i) The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.
- (ii) The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.
- (iii) The calculated seismic factor of safety must equal or exceed 1.00
- (iv) For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

Table 1 summarizes the geometric characteristics of the embankments.



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Table 1 Clifty Creek Facility Geometry

Facility Section	Height (feet)	Crest Width (feet)	Downstream Slope Grade	Upstream Slope Grade
Boiler Slag Pond Section A-A'	41	22	2.5H:1V*	1.75H:1V*
Boiler Slag Pond Section B-B'	31	30	2.5H:1V*	1.5H:1V*
Boiler Slag Pond Section C-C'	35	30	2H:1V*	2H:1V*
Landfill Runoff Collection Pond Section D-D'	61	20	2.5H:1V*	3H:1V*
Landfill Runoff Collection Pond Section E-E'	51	20	2.5H:1V*	4.5H:1V*

*Denotes horizontal to vertical ratio

2.0 GEOLOGY OF THE SITE

The site lies within the Muscatatuck Regional Slope Physiographic Region of Indiana. This gently sloping plain is made of bedrock that is mostly Devonian in age that has been dissected by streams. Along the Ohio River the uplands immediately to the north are rugged and stand in bold relief to the flood plain. The reaches of each drainageway typically contain accumulations of silt, clay, and sand that make up the flat-lying flood plains. The site topography is steep to moderately sloping toward natural drainage channels. Topographic relief between Clifty Creek Power Plant and the uplands to the north is on the order of 350 feet.

Published soils information for the site was obtained from the Soil Survey of Jefferson County, Indiana, (US Department of Agriculture [USDA], Natural Resources Conservation Service [NRCS], 1985). The soil survey indicated the side slopes of Devil's Backbone and the ridge flanks to the north of the site belong to the Eden-Caneyville complex (EgG). These soils are found on steep to very steep slopes ranging from 25 to 60 percent. The Eden-Caneyville complex consists of moderately deep and well-drained soils that formed on slopes facing the Ohio River and on back slopes facing adjacent to tributaries near the river.

Mapping of unconsolidated sediments obtained from Regional Geologic Map, Louisville Sheet, Part B (Indiana Department of Natural Resources [IDNR], 1972) indicates the lowland areas adjacent to the Ohio River are predominantly underlain by clay, silt, sand, and gravel deposited as alluvium, lacustrine and outwash deposits. The glacial deposits in the area are of the Illinoian and Wisconsinan Quaternary age and belong to the Atherton Formation. The overlying more recent alluvial deposits belong to the Martinsville Formation.



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The Atherton Formation consists of coarse- to fine-grained, well-sorted sediments that were deposited by glacial outwash (sand and gravel deposited by glacial meltwater streams), lake sediments and loess. The Martinsville Formation consists of alluvial sediments of non-glacial origin that have been deposited in modern flood plains along the major drainage ways. This formation varies in thickness from a few inches up to 30 feet near rivers.

Available geologic mapping from Bedrock Geology of Indiana (Indiana Geological Survey [IGS] Miscellaneous Map 48, IGS, 1987) shows the site to be underlain by bedrock of the Maquoketa Group. The Maquoketa Group in Indiana is a westward-thinning wedge, 1,000 feet thick in southeastern Indiana and 200 feet thick in northwestern Indiana. Overall, the group consists principally of shale (about 80 percent) and limestone (about 20 percent), although limestone is dominant in some areas. The lower part of the group is almost entirely shale, and the lower part of the shale is dark brown to nearly black. These rocks were deposited during the Upper Ordovician Period.

3.0 FIELD EXPLORATIONS AND SITE RECONNAISSANCE

The borings for the 2009 and 2010 geotechnical exploration were advanced using 3¼-inch inside-diameter hollow-stem augers powered by a truck-mounted drill rig. Standard penetration tests (SPTs) were performed at 2.5-foot intervals in accordance with ASTM D 1586. Undisturbed Shelby tube samples were performed at selected intervals to obtain samples for consolidated-undrained (CU) triaxial compression (ASTM D 4767) and permeability testing (ASTM D 5084-90). Sample depths and recovery amounts are presented on the boring logs. Additionally, disturbed bag samples were collected from auger cuttings obtained from the boreholes.

A Stantec geotechnical engineer directed the drill crews, logged the subsurface materials encountered during the exploration and collected soil samples. During field logging, particular attention was given to each material's color, texture, moisture content, and consistency or relative density.

Following the field explorations, the Shelby tubes and bag samples were transported to Stantec's (or certified vendor's) laboratory for testing. Natural moisture content and unit weight testing were performed on samples extruded from the tubes. Testing consisting of sieve and hydrometer analyses (ASTM D 422) and Atterberg limits (ASTM D 4318) was performed on representative samples in order to classify the soil according the Unified Soil Classification System (USCS). Consolidated undrained triaxial compression tests (ASTM D 4767) and falling head permeability tests (ASTM D 5084) were also performed on Shelby tube samples. Standard Proctor moisture-density testing (ASTM D 698) was performed on disturbed soil bag samples collected from the auger cuttings.



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3.1 BOILER SLAG POND DAM

3.1.1 2010 Geotechnical Exploration

Stantec advanced six borings at the dike of the Boiler Slag Pond Dam near the locations requested by AEP. The boring locations are shown in Appendix A. Borings B-1, B-3, and B-5 were positioned along the crest of the dike and Borings B-2, B-4, and B-6 were located along the downstream toe.

Upon completion of drilling, one-inch diameter standpipe piezometers were installed in four of the borings (Borings B-1, B-3, B-4, and B-5). In these, ten-foot long sections of polyvinyl chloride (PVC) well screen were placed in the borehole with the bottoms at approximate depths ranging from 30 to 40 feet. PVC riser tubing extended to the tops of the piezometers. Flush-mount well covers were installed along the crest of the dike (Borings B-1, B-3, and B-5) and an above-ground steel tube cover was used at the toe of the downstream slope (Boring B-4). Refer to Appendix C for piezometer installation details.

3.1.2 2015 CCR Mandate Site Reconnaissance

Representatives from Stantec visited the Boiler Slag Pond Dam for a site reconnaissance on August 25, 2015. The purpose of this visit was to confirm that physical conditions at the pond, such as geometry of the embankment, pool elevations, etc. had not changed since the completion of the analysis in 2010. The crest and exterior slopes of the pond were walked by Stantec personnel, while the interior slopes were observed from the crest. Evidence of alterations to the pond since 2010 were not observed during the reconnaissance.

3.2 LANDFILL RUNOFF COLLECTION POND DAM

3.2.1 Previous Explorations

Two historical exploration reports were used to develop subsurface profiles and engineering parameters for the onsite material. The Fly Ash Dam Raising Feasibility Report (AEP, 1985) was implemented to obtain geotechnical properties of the dams, dikes, and foundation material to perform a feasibility assessment of raising the dams by 30 feet. Approximately 22 borings with SPT sampling and 11 Cone Penetrometer Test (CPT) borings were performed for this study. This report was used to develop a subsurface profile of the dam and estimate soil properties and shear strength parameters.

The Hydrogeologic Study Report (Applied Geology and Environmental Science, Inc., 2006) summarized the piezometers and field permeability testing performed by various firms. This report was used to develop initial phreatic surfaces for the stability analyses, and the field



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permeability testing data were reviewed to assist in selecting hydraulic conductivity values for soil horizons in the seepage analysis.

A review of the existing data by Stantec revealed a lack of laboratory testing necessary to develop drained (long-term) shear strength parameters. Standard Proctor moisture-density testing was recommended to compare with in-situ total unit weights to estimate the apparent degree of compaction used during construction. The review of the existing data resulted in the additional exploration explained in Section 3.2.2.

3.2.2 2009 Geotechnical Exploration

Stantec advanced four additional borings along the southern dam on November 11 and 19, 2009 to collect undisturbed Shelby tube and disturbed bag samples for laboratory testing. The boring locations are shown in Appendix A. Borings B-7 and B-9 were positioned along the crest of the dam, and Borings B-8 and B-10 were located along the downstream toe of the dam embankment. The borings were numbered in sequence with the six borings drilled at the Boiler Slag Pond Dam, also advanced late in 2009.

3.2.3 2015 Geotechnical Exploration

An additional boring (B-12) was advanced on July 6-7, 2015 to confirm subsurface conditions. This boring was placed on the crest of the dam, between the two cross-sections. The location of the boring can be seen on the site plan in Appendix A. Standard Penetration Test samples were collected at five-foot intervals. These samples were taken to a Stantec laboratory for natural moisture content, hydrometer analyses, and Atterberg limits testing.

3.2.4 2015 CCR Mandate Site Reconnaissance

Representatives from Stantec visited the Landfill Runoff Collection Pond for a site reconnaissance on August 25, 2015. The purpose of this visit was to confirm that physical conditions at the pond, such as geometry of the embankment, pool elevations, etc. had not changed since the completion of the analysis in 2010. The crest and exterior slopes of the pond were walked by Stantec personnel, while the interior slopes were observed from the crest. Evidence of alterations to the pond since 2010 were not observed during the reconnaissance.

4.0 RESULTS OF EXPLORATIONS

Logs of borings are provided in Appendix B and shown graphically on stability analysis cross sections in Appendix I for the 2009 and 2010 explorations. Results of natural moisture content tests and SPTs are provided on the logs adjacent to the appropriate sample. Summaries of engineering classification tests are provided in Appendix D.



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4.1 BOILER SLAG POND DAM

4.1.1 2010 Geotechnical Exploration

4.1.1.1 Boring B-1

Boring B-1 was on the crest along cross-section A-A' of the Boiler Slag Pond Dam. The surface elevation of this boring was 473.4 feet.

Lean clay with sand was observed from the surface of the boring to a depth of 67.5 feet (Elevation 405.9 feet). From the surface of the boring to a depth of 37.5 feet (Elevation 435.9 feet), this material was described as light yellowish brown with light gray, damp to moist, and medium stiff to stiff. Natural moisture contents ranged from 15 to 23 percent and SPT N-values varied from 7 to 15 blows per foot (bpf). A liquid limit of 32 percent and a plasticity index of 13 percent were determined for a sample from this horizon. This sample was classified as CL, lean clay with sand, according to the Unified Soil Classification System (USCS) and A-6 (10) according to the Association of American State and Highway Transportation Officials (AASHTO) system. The average total unit weight of undisturbed samples was 131 pounds per cubic foot (pcf).

From a depth of 37.5 to 67.5 feet (Elevation 435.9 to 405.9 feet), the lean clay with sand was described as light yellowish brown with light gray, moist to wet, and very soft to medium stiff. Natural moisture contents ranged from 20 to 37 percent and SPT N-values varied from 2 to 7 blows per foot. A liquid limit of 28 percent and a plasticity index of 12 percent were determined for this soil. A Shelby tube sample yielded a total unit weight of 129 pounds per cubic foot. A representative sample from this layer classified as CL, lean clay with sand, according to the USCS and A-6 (8) according to the AASHTO system.

Bedrock, described as weathered gray shale, was encountered at a depth of 67.5 feet (Elevation 405.9 feet) and was augered to a boring termination depth of 71.5 feet (Elevation 401.9 feet). Groundwater was observed during the drilling at a depth of 40.0 feet (Elevation 433.4 feet) during drilling.

4.1.1.2 Boring B-2

Boring B-2 was advanced at the downstream toe along the same cross-section as Boring B-1 at a surface elevation of 444.0 feet.

From the surface of the boring to a depth of 51.5 feet (Elevation 392.5 feet), lean clay with sand was observed. The top 30 feet of this deposit was described as light yellowish brown with gray, moist to wet, and soft to very stiff. Moisture contents ranged from 17 to 32 percent and SPT N-values varied from 2 to 19 bpf, with an average of 7 blows per foot. The average total unit weight of the soil was 124 pounds per cubic foot.



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The lower 21.5 feet of the lean clay with sand was described as gray, moist to wet, and soft to medium stiff. Natural moisture contents ranged from 25 to 35 percent and SPT N-values varied from 2 to 6 blows per foot. A liquid limit of 33 percent and plasticity index of 18 percent was determined for this material. A representative sample of this soil classified as CL, lean clay with sand according to the USCS and A-6 (13) according to the AASHTO system. Total unit weights of 117 and 121 pcf were determined for Shelby tube samples.

From a depth of 51.5 to 55.5 feet (Elevation 392.5 to 388.5 feet), well-graded gravel with silt and sand was observed. Bedrock was encountered below this material, described as shale, gray, hard, and medium bedded. Groundwater was observed at a depth of 22.5 feet (Elevation 421.5 feet) during drilling.

4.1.1.3 Boring B-3

Boring B-3 was positioned on the crest of the dike along cross-section B-B'. The surface elevation of the boring was 471.6 feet.

Lean clay with sand, described as light yellowish brown with light gray, was observed from the boring surface to a depth of 37.5 feet (Elevation 434.1 feet). The soil was further described as damp to moist and medium-stiff to very stiff. Moisture contents ranged from 15 to 22 percent and SPT N-values varied from 8 to 17 blows per foot. The average total unit weight was 131 pounds per cubic foot.

Gray lean clay with sand was observed below the upper soil horizon to the termination depth of 71.5 feet (Elevation 400.1 feet). This soil was described as moist and soft to very stiff. Moisture contents ranged from 20 to 40 percent and SPT N-values varied from 2 to 18 bpf, with an average of 6 blows per foot. The average total unit weight was 126 pounds per cubic foot.

Groundwater was observed at a depth of 40.0 feet (Elevation 431.6 feet) during drilling. Bedrock was not encountered.

4.1.1.4 Boring B-4

Boring B-4 was located along the downstream toe of the dike, downhill from Boring B-3, at a surface elevation of 444.0 feet.

Brown to dark gray lean clay with sand was observed from the surface of the boring to a depth of 15.0 feet (Elevation 429.0 feet). The soil was described as damp to moist and medium stiff to very stiff. Natural moisture contents ranged from 14 to 22 percent and SPT N-values varied from 7 to 16 blows per foot.

Gray lean clay with sand was encountered below the upper soil horizon to a depth of 57.5 feet (Elevation 386.5 feet) and was described as moist to wet and soft to stiff. Moisture contents



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varied from 21 to 35 percent and SPT N-values varied from 3 to 9 blows per foot. A representative sample yielded a liquid limit of 25 percent and a plasticity index of 8 percent. This material classified as CL, lean clay with sand, according to the USCS and A-4 (4) according to the AASHTO system.

Underlying the lean clay with sand, well-graded gravel with silt and sand was observed to a termination depth of 71.5 feet (Elevation 372.5 feet). This material was described as gray, wet, and dense to very dense. Moisture contents ranged from 9 to 13 percent and SPT N-values varied from 39 to over 50 blows per foot. A representative sample of this material tested as non-plastic and classified as GW-GM, well-graded gravel with silt and sand, according to the USCS and A-1-a (1) according to the AASHTO system.

Bedrock was not encountered in the boring. Groundwater was observed at a depth of 22.5 feet (Elevation 421.5 feet) during drilling.

4.1.1.5 Boring B-5

Boring B-5 was advanced from the crest of the dike on cross-section C-C'. The surface elevation was 468.7 feet.

Lean clay with sand was observed from the surface of Boring B-5 to a depth of 40.0 feet (Elevation 428.7 feet). The soil was described as light yellowish brown with light gray, damp to moist, and medium stiff to very stiff. Natural moisture contents ranged from 15 to 25 percent and SPT N-values varied from 6 to 19 blows per foot. The average total unit weight of the soil was 128 pounds per cubic foot.

Additional lean clay with sand was encountered below the uppermost layer to a depth of 47.5 feet (Elevation 421.2 feet). This material was described as gray, moist to wet, and soft. Natural moisture contents ranged from 23 to 25 percent and SPT N-values varied between 3 and 4 blows per foot. The total unit weight was 119 pounds per cubic foot.

Below the lean clay with sand, sandy silt was observed to the termination depth of 71.5 feet (397.2 feet). The sandy silt was described as light yellowish brown to gray, wet, and soft to stiff. Moisture contents ranged from 22 to 30 and SPT N-values varied from 2 to 13 bpf, with an average of 7 blows per foot. A representative sample from this horizon tested as non-plastic and classified as ML, sandy silt, according to the USCS and A-4 (0) according to the AASHTO system.

Bedrock was not encountered in the boring. Groundwater was encountered at a depth of 45.0 feet (Elevation 423.7 feet) during drilling.

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4.1.1.6 Boring B-6

Boring B-6 was advanced from a surface elevation of 445.5 feet near the southeast toe of slope below Boring B-5.

Lean clay with sand was encountered from the surface to a depth of 27.5 feet (Elevation 418.0 feet). This material was described as brown to gray, damp to moist, and very soft to very stiff. Natural moisture contents ranged from 16 to 32 percent and SPT N-values varied from 0 to 18 bpf, with an average of 6 blows per foot. The average total unit weight was 117 pounds per cubic foot.

Sandy silt was observed below the lean clay with sand to the boring termination depth of 71.5 feet (Elevation 374.0 feet). This soil was described as gray, moist to wet, and very soft to stiff. Moisture contents ranged from 27 to 40 percent and SPT N-values varied from 1 to 11 bpf, with an average of 5 blows per foot. The total unit weight was 117 pounds per cubic foot.

Bedrock was not encountered in the boring. Groundwater was observed at a depth of 30.0 feet (Elevation 415.5 feet) during drilling.

4.1.1.7 Piezometers

Piezometers were installed on the crest in Borings B-1, B-3, and B-5, and at the downstream toe in Boring B-4. Details of piezometers installations are shown in Appendix C. Ten-foot long piezometers screens were installed with the tips at approximate depths of 40 feet along the crest and 30 feet at the downstream toe of slope. Table 2 summarizes the installations and first two readings performed on the piezometers.

Table 2 Summary of Piezometer Elevations for the Boiler Slag Pond Dam

Boring No.	Top of Piezometer (feet)	Tip of Piezometer (feet)	Piezometric Reading on 11/13/09 (feet)	Piezometric Reading on 02/01/10 (feet)
B-1	473.4	433.4	434.2	434.1
B-3	471.8	431.6	440.6	434.6
B-4	446.7	414.0	430.7	428.5
B-5	469.0	428.7	434.9	430.4



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4.2.1 2009 Geotechnical Exploration

4.2.1.1 Boring B-7

Boring B-7 was advanced from the crest of the dam along cross-section D-D'. The surface elevation of the boring was 503.4 feet. Approximately 0.5 feet of asphalt pavement and gravel base was observed at the surface of the boring.

Below the pavement and gravel base, lean clay was observed to a boring termination depth of 29.0 feet (Elevation 474.4 feet). The lean clay was described as yellow and light gray, moist, and stiff. Three undisturbed Shelby tube samples were obtained from a depth of 23.0 to 29.0 feet (Elevation 480.4 to 474.4 feet). Natural moisture contents of those samples ranged from 18 to 24 percent, and total unit weights varied from 128 to 133 pounds per cubic foot. A representative sample yielded a liquid limit of 28 percent and a plasticity index of 8. This sample classified as CL, lean clay, according to the USCS and A-4 (7) according to the AASHTO system.

Neither bedrock nor groundwater was encountered during drilling.

4.2.1.2 Boring B-8

Boring B-8 was located at the toe of slope downstream of Boring B-7. The surface elevation of the boring was 441.5 feet. From the surface of the boring to a depth of 16.0 feet (Elevation 425.5 feet), the soil was visually described as yellow and light gray, damp to moist, silty clay.

Below the silty clay, lean clay was encountered to a depth of 29.0 feet (Elevation 412.5 feet). The lean clay was described as yellowish brown to light gray and moist. Two undisturbed Shelby tube samples were taken from this horizon at depths of between 25.0 and 29.0 feet (Elevation 416.5 to 412.5 feet). Natural moisture contents ranged from 24 to 27 percent, and total unit weights ranged from 124 to 130 pounds per cubic foot. A representative sample of this material yielded a liquid limit of 38 percent and a plasticity index of 17 percent. The sample classified as CL, lean clay according to the USCS and A-6 (15) according to the AASHTO system.

Soil described as lean clay with sand was observed beneath the lean clay to the boring termination depth of 31.0 feet (Elevation 410.5 feet). The lean clay with sand was further described as yellowish brown and light gray and moist. Shelby tube samples yielded moisture contents of 22 and 24 percent and total unit weights of 126 and 129 pounds per cubic foot. This soil had a liquid limit of 45 percent and a plasticity index of 25 percent. The soil classified as CL, lean clay with sand according to the USCS and A-7-6 (20) according to the AASHTO system.

Neither bedrock nor groundwater was encountered during drilling.



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4.2.1.3 Boring B-9

Boring B-9 was advanced along the crest of cross-section E-E' at a surface elevation of 504.3 feet. Asphalt pavement and gravel base was observed at the surface of the boring to a depth of 0.5 feet.

Lean clay was encountered below the pavement to the boring termination depth of 22.0 feet (Elevation 482.3 feet). The lean clay was described as yellow to light gray and damp to moist. Three undisturbed Shelby tube samples were obtained from a depth of 16.0 to 22.0 feet (Elevation 488.3 to 482.3 feet). Natural moisture contents ranged from 17 to 23 percent, and total unit weights varied from 119 to 135 pounds per cubic foot. A sample of this material yielded a liquid limit of 39 percent and a plasticity index of 19 percent. This sample classified as CL, lean clay, according to the USCS and A-6 (17) according to the AASHTO system.

Neither bedrock nor groundwater was encountered during drilling.

4.2.1.4 Boring B-10

Boring B-10 was positioned near the toe below Boring B-9. The surface elevation was 457.3 feet.

Silty clay with sand was observed from the surface of the boring to a depth of 13.2 feet (Elevation 444.1 feet) and from a depth of 16.0 feet to the termination depth of 18.0 feet (Elevation 441.3 to 439.3 feet). This soil was described as yellow to light gray and damp to moist. Two undisturbed Shelby tube samples were taken and natural moisture contents ranged from 21 to 28 percent. Total unit weights of the samples ranged from 116 to 124 pounds per cubic foot. A representative sample of this material yielded a liquid limit of 28 percent and a plasticity index of 7 percent. The sample classified as CL-ML, silty clay with sand according to the USCS and A-4 (5) according to the AASHTO system.

From a depth of 13.2 to 16.0 feet (Elevation 444.1 to 441.3 feet) a layer of silty sand was encountered and describe as gray-brown and damp to moist. One Shelby tube sample was taken from this layer. A representative sample of this soil classified as non-plastic SM, silty sand, according to the USCS and A-2-4 (0) according to the AASHTO system.

4.2.2 2015 Geotechnical Exploration

Boring B-12 was advanced on the crest of the dam between the analysis cross-sections. The ground surface elevation of the boring was estimated to be 503.9 feet. A layer of asphalt with gravel base was encountered at the surface of the boring to a depth of 0.4 feet (Elevation 503.5 feet).

Beneath the asphalt and gravel base, lean clay with sand was encountered to a depth of 40.0 feet (Elevation 463.9 feet). This material was described as gray, damp, and medium stiff to stiff.



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The natural moisture contents ranged from 18 to 28 percent and the SPT N-values varied from 7 to 15 blows per foot. The liquid limit of this material ranged from 31 to 43 percent and the plasticity index varied from 13 to 22 percent. The material classified as CL, lean clay with sand, according to the USCS and A-6 (7) or A-7-6 (15) according to the AASHTO system.

Silty clay with sand was observed beneath the lean clay with sand to a depth of 50.0 feet (Elevation 453.9 feet). This material was described as brown, moist, and medium stiff to very stiff. The natural moisture contents ranged from 16 to 19 percent and the SPT N-values varied from 8 to 16 blows per foot. A representative sample of this material yielded a liquid limit of 26 percent and a plasticity index of 7 percent. The material classified as CL-ML, silty clay with sand, according to the USCS and A-4 (4) according to the AASHTO system.

Cohesionless material was encountered beneath the silty clay with sand to the depth of 90.0 feet (Elevation 413.9 feet). This material was silt, silt with sand, silty sand, or sand; and was described as brown or gray, damp to wet, and loose to medium dense. The natural moisture contents ranged from 15 to 28 percent and the SPT N-values varied from 6 to 28 blows per foot. Samples from these materials tested as non-plastic. The material classified as ML (sandy silt, silt, or silt with sand) or SM (silty sand) according to the USCS and A-4 (0) according to the AASHTO system.

Beneath the cohesionless material, lean clay was encountered to the boring termination depth of 101.5 feet (402.4 feet). This material was described as gray, moist, and medium stiff to very stiff. The natural moisture content ranged from 23 to 27 percent and the SPT N-values varied from 8 to 19 blows per foot. A representative sample from this material yielded a liquid limit of 42 percent and a plasticity index of 23 percent. The sample classified as CL, lean clay, according to the USCS and A-7-6 (20) according to the AASHTO system.

5.0 LABORATORY TESTING

Laboratory tests in addition to the natural moisture content, classification tests, and unit weight tests mentioned in Section 4 were conducted on samples taken from the Boiler Slag Pond Dam (2010 Geotechnical Exploration) and Landfill Runoff Collection Pond (2009 Geotechnical Exploration). The results from the additional testing are summarized in the following sections.

5.1 BOILER SLAG POND DAM

5.1.1 Consolidated-Undrained Triaxial Compression Testing

Three consolidated-undrained (CU) triaxial compression tests were performed on undisturbed samples collected from the borings. These tests were performed in accordance with ASTM D



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4767, and detailed results of the tests are provided in Appendix E. The samples were described as lean clay with sand. Table 3 shows a summary of the CU triaxial tests performed.

Table 3 Summary of CU Triaxial Compression Testing for the Boiler Slag Pond Dam

Boring Nos.	Depth (feet)	Soil Description	Material	Effective Cohesion, c' (psf)	Effective Angle of Internal Friction, ϕ' (deg.)
B-3, B-5	8.1 – 11.2	Lean Clay with Sand	Embankment	330	33.2
B-2, B-4	18.2 – 24.3	Lean Clay with Sand	Foundation	320	27.2
B-1, B-3	43.1 – 48.7	Lean Clay with Sand	Foundation	170	30.2

5.1.2 Permeability Testing

Four permeability tests (ASTM D 5084, Falling-Head, Method C, Rising Tailwater) were performed on undisturbed samples. Detailed data sheets showing the results of the tests are provided in Appendix F. Vertical hydraulic conductivities ranged from 8.7×10^{-9} to 1.6×10^{-6} centimeters per second. The samples were described as lean clay with sand. Table 4 summarizes the results of the permeability tests.

Table 4 Summary of Permeability Testing for the Boiler Slag Pond Dam

Boring No.	Depth, feet	Soil Description	Material	Vertical Hydraulic Conductivity, cm/second
B-1	16.1 – 16.6	Lean Clay with Sand	Embankment	1.44×10^{-7}
B-2	42.6 – 43.1	Lean Clay with Sand	Foundation	8.70×10^{-9}
B-4	7.6 – 8.1	Lean Clay with Sand	Embankment	1.58×10^{-6}
B-6	17.6 – 18.1	Lean Clay with Sand	Foundation	2.01×10^{-7}

5.1.3 Moisture-Density Testing

Three standard Proctor moisture-density tests (ASTM D 698) were performed on bag samples taken from auger cuttings. The data sheets for these tests are provided in Appendix G.



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Maximum dry densities ranged from 113.0 to 117.4 pcf and optimum moisture contents varied from 13.4 to 15.8 percent. The samples were described as lean clay with sand. Table 5 summarizes the results of the tests.

Table 5 Summary of Moisture-Density Testing for the Boiler Slag Pond Dam

Boring No.	Depth, feet	Material	Soil Description	Maximum Dry Density, pcf	Optimum Moisture Content, %
B-1	5.0 +/- 2.0	Embankment	Lean Clay with Sand	117.4	13.4
B-5	7.5 +/- 2.0	Embankment	Lean Clay with Sand	113.0	15.8

These moisture-density tests were performed to compare with natural moisture contents and unit weights of the soils. Within the embankment soils, natural moisture contents ranged from 15 to 25 percent with an average of 19 percent. Dry densities of the embankment soil ranged from 106 to 115 pcf, with an average of 110 pounds per cubic foot. The results of these tests indicate that the average natural moisture content of the embankment soil is 3 to 5 percent above optimum moisture and that the average percent compaction of the embankment soil is on the order of 94 to 97 percent of the standard Proctor maximum density.

5.2 LANDFILL RUNOFF COLLECTION POND

5.2.1 Consolidated-Undrained Triaxial Testing

Four CU triaxial compression tests were performed on undisturbed samples collected from the borings. These tests were performed in accordance with ASTM D 4767, and detailed results of the tests are provided in Appendix E. The samples were described as lean clay, lean clay with sand, or sandy clay. Table 6 shows a summary of the CU triaxial tests performed.

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Table 6 Summary of CU Triaxial Compression Testing for the Landfill Runoff Collection Pond

Boring No.	Depth (feet)	Soil Description	Material	Effective Cohesion, c' (psf)	Effective Angle of Internal Friction, ϕ' (deg.)
B-7	25.8 – 29.0	Lean Clay	Embankment	430	29.3
B-8	25.8 – 30.9	Lean Clay with Sand	Foundation	410	28.0
B-9	17.4 – 21.4	Lean Clay	Embankment	360	25.7
B-10	13.4 – 18.0	Sandy Clay	Foundation	300	35.1

5.2.2 Permeability Testing

Four permeability tests (ASTM D 5084, Falling-Head, Method C, Rising Tailwater) were performed on undisturbed samples. Detailed data sheets showing the results of the tests are provided in Appendix F. Vertical hydraulic conductivities ranged from 3.4×10^{-8} to 1.4×10^{-7} centimeters per second. The samples were described as lean clay, lean clay with sand, or silt. Table 7 summarizes the results of the permeability tests.

Table 7 Summary of Permeability Testing for the Landfill Runoff Collection Pond

Boring No.	Depth, feet	Material	Soil Description	Vertical Hydraulic Conductivity, cm/second
B-7	27.4 – 27.7	Embankment	Lean Clay	8.4×10^{-8}
B-8	29.7 – 30.9	Foundation	Silt	3.4×10^{-8}
B-9	18.3 – 18.9	Embankment	Lean Clay	6.2×10^{-8}
B-10	16.4 – 16.7	Foundation	Lean Clay with Sand	1.4×10^{-7}

5.2.3 Moisture-Density Testing

One standard Proctor moisture-density test (ASTM D 698) was performed on a bag sample of embankment soil taken from auger cuttings. The data sheet for this test is provided in Appendix



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G. The maximum dry density was 110.6 pcf and the optimum moisture content was 16.9 percent. The sample was described as lean clay. Table 8 summarizes the results of the tests.

Table 8 Summary of Moisture-Density Testing for the Landfill Runoff Collection Pond

Boring No.	Depth, feet	Material	Soil Description	Maximum Dry Density, pcf	Optimum Moisture Content, %
B-7	7.0 +/- 2.0	Embankment	Lean Clay	110.6	16.9

The moisture-density test was performed to compare with in-situ natural moisture contents and unit weights of the soils. Within the embankment soils, natural moisture contents varied from 17 to 24 percent with an average of 20 percent. Dry densities of the embankment soil ranged from 99 to 114 pounds per cubic foot, with an average of 108 pounds per cubic foot. The results of these tests indicate that the average natural moisture content of the embankment soil is about 3 percent above optimum moisture and that the average percent compaction of the embankment soil is approximately 98 percent of the standard Proctor maximum density.

6.0 ENGINEERING ANALYSIS

6.1 BOILER SLAG POND DAM

Based on the review of available information, results of the geotechnical exploration and results of laboratory testing, Stantec performed engineering analyses of the Boiler Slag Pond Dam in 2010. This included liquefaction, seepage, and slope stability analysis of three cross sections. The procedures used and the results of the analyses are presented in the following paragraphs. The results of the liquefaction analysis are shown in Appendix H, and the cross section drawings showing the results of the seepage and stability analyses are provided in Appendix I. Appendix J provides an explanation of derivations of shear strength, seepage, and liquefaction analysis parameters.

6.1.1 Engineering Analyses Performed in 2015 as Part of CCR Mandate

6.1.1.1 Liquefaction Analysis

The liquefaction analysis conducted in 2010 was revisited as part of the CCR Mandate. The details for this analysis are contained in Appendix H. Similar to the analysis performed in 2010, a screening process was used to determine if the cohesive material encountered in the borings has the potential for liquefaction. The screening process was conducted for four samples which had liquid limits below 37 percent. According to the Seed et al and Bray and Sancio plots



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supplied in Appendix H, one sample could be labeled as susceptible to liquefaction and another could be labeled as moderately susceptible to liquefaction.

The remaining cohesionless material encountered in the critical cross-sections was tested for liquefaction as a coarse-grained analysis similar to the one conducted in 2010. According to the CCR Mandate, for dikes constructed of soils that have a susceptibility to liquefaction, the calculated factor of safety must equal or exceed 1.20. Test data from Borings B-1 and B-2, representative of cross-section A-A', Boring Nos. B-3 and B-4, representative of cross-section B-B', and B-5 and B-6, representative of cross-section C-C' was used. Soil characteristics (grain size, plasticity, etc.) from SPT and Shelby tube samples were summarized to assess liquefaction potential. The copies of the spreadsheets used for the calculations appear in Appendix H and provide the soil, test data, and calculations used in the assessment.

It was assumed during the screening process for potential liquefaction that the steady-state water elevation consistent with that developed during the stability analysis would be used as the groundwater elevation. Unsaturated soils above this elevation were considered not liquefiable. Also the dike embankment materials, consisting of engineered fill, were not considered liquefiable.

Factors of safety against liquefaction were estimated for soil layers predicted to be potentially liquefiable during the screening process. As a result of recent industry publications that attempted to update certain correlations that had larger uncertainty that are used in the calculations for the factor of safety, slight differences in the factors of safety were obtained than those reported in 2010. Inputs such as depth, material properties, seismic accelerations, etc. have not been altered. Ranges and averages of these factors of safety for the potentially liquefiable soil layers are summarized in Table 9.

Table 9 Liquefaction Factor of Safety for the Boiler Slag Pond Dam, CCR Mandate

Boring No.	Depth (feet)	Elevation (feet)	Unified Soil Classification	Liquefaction FS, Range	Liquefaction FS, Average
B-2	51.5 – 56.0	392.5 – 388.0	GW-GM	10.00	10.00
B-4	57.5 – 71.5	386.5 – 372.5	GW-GM	10.00	10.00
B-5	47.5 – 71.5	421.2 – 397.2	ML	1.60 – 3.52	2.41
B-6	27.5 – 71.5	418.0 – 374.0	ML	1.08 – 2.64	1.73

The range of factors of safety for each soil horizon represents factors of safety calculated from each individual corrected N-value at that specific depth and overburden pressure. Due to the variable and somewhat unreliable nature associated with the SPT, it is recommended that the



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liquefaction factors of safety be evaluated according to the average values shown in Table 9. The average liquefaction factors of safety against liquefaction ranged from 1.73 to 10.00 and are considered acceptable.

6.1.1.2 Seepage Analysis

The seepage analysis conducted in 2010 was reviewed as part of the CCR Mandate. The seepage models used in the SEEP/W product were calibrated to recent piezometric data and visual field operations. Changes to the material properties developed in Appendix J of this report were not deemed necessary.

The 2010 analysis used a normal pool elevation of 442 feet to establish the piezometric line. During the 2015 site reconnaissance with AEP personnel, it was learned that the normal pool elevation is currently 448 feet and is not expected to change. As a result, a piezometric line has been adjusted for the current normal pool elevation of 448 feet, and has been used during the CCR Mandate review. The seepage analysis conducted at the critical cross-sections of A-A', B-B', and C-C' were reviewed.

The results of the seepage analysis were used to revise the stability cross-sections.

6.1.1.3 Stability Analysis

The stability analysis conducted in 2010 was reviewed as part of the CCR Mandate, using the results of the seepage analysis review in Section 6.1.1.2. Similar to 2010, SLOPE/W was the software used during the analysis. The drained shear strength parameters developed in 2010, located in Appendix J, were maintained for the updated analysis. Undrained shear strength parameters were not derived in 2010. These parameters were determined by CU test data for the Embankment Fill and Lean Clay with Sand. Undrained shear strength parameters for cohesionless materials were taken to be identical to the drained shear strength parameters.

Table 10 summarizes the drained and undrained shear strength parameters used in the analysis.

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Table 10 Shear Strength Parameters for CCR Mandate Review

Material	Unit Weight (pcf)	Drained Shear Strengths		Undrained Shear Strengths	
		ϕ' (deg.)	Effective Cohesion (psf)	ϕ (deg.)	Cohesion (psf)
Embankment	130	33.2	165	13	600
Lean Clay with Sand	119	27.2	160	5	1,200
Gravel with Silt and Sand	130	35	0	35	0
Bottom Ash	115	28	0	28	0
Silty Sand	130	30	0	30	0

The upstream and downstream slopes of each cross-section were analyzed, incorporating the auto locate and entry/exit search routines to locate the critical slip surface. Once the potential failure surface with the lowest factor of safety was identified, the optimization routine was run.

When the surface slope is composed of a material with low effective cohesion, an infinite slope failure (shallow sliding parallel to the surface) will be critical. A minimum failure depth of ten feet was specified for each section, to eliminate the evaluation of surficial sloughing and erosional types of instability.

For this review, SLOPE/W was used to investigate one normal pool elevation, considered the maximum steady-state pool, and one PMF pool elevation:

- Current normal pool level of 448 feet.
- 50 Percent PMF pool level of 468.4 feet, applied as a steady-state load condition within SLOPE/W.

Using the drained and undrained strength parameters listed in Table 10, the existing dam was analyzed at the three critical cross sections selected for the CCR review. The undrained materials strengths were used in the seismic analyses.

A summary of the factors of safety are presented in Table 13 at the end of this section and printouts of the GeoStudio runs are presented in Appendix I.

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6.2 LANDFILL RUNOFF COLLECTION POND

Based on the review of available information, results of geotechnical exploration and results of laboratory testing, Stantec performed engineering analyses of the Landfill Runoff Collection Pond in 2009. This included liquefaction, seepage, and slope stability analysis of two cross sections. The procedures used and the results of the analyses are presented in the following paragraphs. The results of the liquefaction analysis are shown in Appendix H, and the cross section drawings showing the results of the seepage and stability analyses are provided in Appendix I. Appendix J provides an explanation of derivations of shear strength, seepage, and liquefaction analysis parameters.

6.2.1 Engineering Analyses Performed in 2015 as Part of CCR Mandate

6.2.1.1 Liquefaction Analysis

The liquefaction analysis conducted in 2010 as part of the 2009 geotechnical exploration was revisited as part of the CCR Mandate. The details for this analysis are contained in Appendix H. Similar to the analysis performed in 2010, a screening process was used to determine if the cohesive material encountered in the borings has the potential for liquefaction. The screening process was conducted for nine samples, four of which had liquid limits below 37 percent. According to the Seed et al and Bray and Sancio plots supplied in Appendix H, none of the samples are considered susceptible to liquefaction.

The remaining cohesionless material encountered in the critical cross-sections was tested for liquefaction as a coarse-grained analysis similar to the one conducted in 2010. According to the CCR Mandate, for dikes constructed of soils that have a susceptibility to liquefaction, the calculated factor of safety must equal or exceed 1.20. Test data from historic Borings SS2-1 and SS2-4, representative of cross-section D-D' and historic Borings SI-1, SS3-1, and SS3-4, representative of cross-section E-E', were used. Soil characteristics (grain size, plasticity, etc.) from SPT and Shelby tube samples were summarized to assess liquefaction potential. The copies of the spreadsheets used for the calculations appear in Appendix H and provide the soil, test data, and calculations used in the assessment.

It was assumed during the screening process for potential liquefaction that the steady-state water elevation consistent with that developed during the stability analysis would be used as the groundwater elevation. Unsaturated soils above this elevation were considered not liquefiable. Also the dike embankment materials, consisting of engineered fill, were not considered liquefiable.

Factors of safety against liquefaction were estimated for soil layers predicted to be potentially liquefiable during the screening process. As a result of recent industry publications that attempted to update certain correlations that had larger uncertainty that are used in the



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calculations for the factor of safety, slight differences in the factors of safety were obtained than those reported in 2010. Inputs such as depth, material properties, seismic accelerations, etc. have not been altered. Ranges and averages of these factors of safety for the potentially liquefiable soil layers are summarized in Table 11.

Table 11 Liquefaction Factor of Safety for the Boiler Slag Pond Dam, CCR Mandate

Boring No.	Depth (feet)	Elevation (feet)	Unified Soil Classification	Liquefaction FS, Range	Liquefaction FS, Average
SI-1	14.0 – 26.0	442.6 – 430.6	ML	2.06 – 2.40	2.23
SI-1	26.0 – 36.0	430.6 – 420.6	SC	10.00	10.00
SI-1	36.0 – 41.0	420.6 – 415.6	SM	5.02	5.02
SI-1	41.0 – 79.5	415.6 – 377.1	ML	2.08 – 10.00*	4.87
SS2-1	61.0 – 66.0	443.5 – 438.5	ML	6.22	6.22
SS2-1	71.0 – 86.0	443.5 – 418.5	SM	2.41 – 10.00	6.31
SS2-4	16.0 – 21.0	423.8 – 418.8	SM	3.29	3.29
SS2-4	61.0 – 64.0	388.8 – 385.8	GC	3.50	3.50
SS3-1	36.0 – 46.0	468.5 – 458.5	ML	3.36 – 4.92	4.14
SS3-1	46.0 – 51.0	458.5 – 453.5	SP	5.34	5.34
SS3-1	51.0 – 56.0	453.5 – 448.5	SC	10.00	10.00
SS3-1	56.0 – 66.0	448.5 – 438.5	SP	3.28 – 3.84	3.56
SS3-1	66.0 – 71.0	438.5 – 433.5	SM	5.03	5.03
SS3-1	71.0 – 86.0	433.5 – 418.5	SP	2.93 – 10.00	6.25
SS3-1	86.0 – 96.0	418.5 – 408.5	SM	5.53 – 6.09	5.81
SS4-1	41.0 – 46.0	464.6 – 459.6	ML	3.28	3.28
SS4-1	46.0 – 66.0	459.6 – 439.6	SM	2.32 – 4.51	3.60
SS4-1	71.0 – 76.0	434.6 – 429.6	SC	1.83	1.83
SS4-1	76.0 – 94.0	429.6 – 411.6	ML	4.01 – 6.30	5.62

*Typical range is 2.08 – 2.93, typical average is 3.16



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6.2.1.2 Seepage Analysis

The seepage analysis conducted in 2010 as a part of the 2009 geotechnical exploration was reviewed as part of the CCR Mandate. The seepage models used in the SEEP/W product were calibrated to recent piezometric data and visual field operations. Changes to the material properties developed in Appendix J of this report and the piezometric lines developed were not deemed necessary. The seepage analysis conducted at the critical cross-sections of D-D' and E-E' were reviewed.

The results of the seepage analysis were used to revise the stability cross-sections.

6.2.1.3 Stability Analysis

The stability analysis conducted in 2010 was reviewed as part of the CCR Mandate, using the results of the seepage analysis review in Section 6.2.1.2. Similar to 2010, SLOPE/W was the software used during the analysis. The drained shear strength parameters developed in 2010, located in Appendix J, were maintained for the updated analysis. Undrained shear strength parameters were not derived in 2010. These parameters were determined by CU test data for the Embankment and Lean Clay with Sand. The undrained shear strength parameters for the silty clay with sand layer were taken from established typical value tables. Undrained shear strength parameters for cohesionless materials were taken to be identical to the drained shear strength parameters.

Table 12 summarizes the drained and undrained shear strength parameters used in the analysis.

Table 12 Shear Strength Parameters for CCR Mandate Review

Material	Unit Weight (pcf)	Drained Shear Strengths		Undrained Shear Strengths	
		ϕ' (deg.)	Effective Cohesion (psf)	ϕ (deg.)	Cohesion (psf)
Embankment	129	27.5	198	21	1,400
Lean Clay with Sand	127	28	206	17	1,200
Sandy Silt	125	30	0	30	0
Silty Sand	94	30	0	30	0
Clayey Gravel with Sand	130	35	0	35	0
Fly Ash	115	25	0	25	0
Silty Clay with Sand	118	34	152	20	1,000



**REPORT OF CCR RULE STABILITY ANALYSES
AEP CLIFTY CREEK POWER PLANT
BOILER SLAG POND DAM AND LANDFILL RUNOFF COLLECTION POND**

ENGINEERING ANALYSIS
February 16, 2016

The upstream and downstream slopes of each cross-section were analyzed, incorporating the auto locate and entry/exit search routines to locate the critical slip surface. Once the potential failure surface with the lowest factor of safety was identified, the optimization routine was run.

When the surface slope is composed of a material with low effective cohesion, an infinite slope failure (shallow sliding parallel to the surface) will be critical. Failure was defined as any slip surface that begins in the crest with a reasonable depth of failure. A minimum failure depth was specified for each section, to eliminate the evaluation of surficial sloughing and erosional types of instability.

For this review, SLOPE/W was used to investigate one normal pool elevation and one PMF pool elevation:

- Current normal pool level of 485 feet.
- PMF pool level of 501.4 feet, applied as a surcharge load within SLOPE/W.

Using the drained and undrained strength parameters listed in Table 12, the existing dam was analyzed at the three critical cross sections selected for the CCR review. The undrained shear strength parameters were used in the seismic analyses.

A summary of the factors of safety are presented in Table 14 at the end of this section and printouts of the GeoStudio runs are presented in Appendix I.

**REPORT OF CCR RULE STABILITY ANALYSES
AEP CLIFTY CREEK POWER PLANT
BOILER SLAG POND DAM AND LANDFILL RUNOFF COLLECTION POND**

ENGINEERING ANALYSIS
February 16, 2016

Table 13 Summary of Computed Factors of Safety for the West Boiler Slag Pond Dam, 2015 CCR Mandate

Headwater Pool	Drainage	Incipient Motion	Seismic Load Case	Acceptance Criteria	Factor of Safety		
					A-A'	B-B'	C-C'
Normal Pool Elevation (448 feet)	Drained	Downstream	No	1.50	2.30	2.44	2.30
Normal Pool Elevation (448 feet)		Upstream		1.50	1.88	1.63	2.73
50% PMF Elevation (462.8 feet)		Downstream		1.40	2.30	2.44	2.18
50% PMF Elevation (462.8 feet)		Upstream		1.40	2.13	1.95	3.88
Normal Pool Elevation (448 feet)	Undrained	Downstream	Yes	1.00	1.35	1.30	1.53
Normal Pool Elevation (448 feet)		Upstream		1.00	1.34	1.30	2.25

Table 14 Summary of Computed Factors of Safety for the Landfill Runoff Collection Pond Dam, 2015 CCR Mandate

Headwater Pool	Drainage	Incipient Motion	Seismic Load Case	Acceptance Criteria	Factor of Safety	
					D-D'	E-E'
Normal Pool Elevation (485 feet)	Drained	Downstream	No	1.50	1.85	1.99
Normal Pool Elevation (485 feet)		Upstream		1.50	2.73	3.51
PMF Elevation Surcharge (501.4 feet)		Downstream		1.40	1.81	1.99
PMF Elevation Surcharge (501.4 feet)		Upstream		1.40	3.47	4.51
Normal Pool Elevation (485 feet)	Undrained	Downstream	Yes	1.00	1.42	1.64
Normal Pool Elevation (485 feet)		Upstream		1.00	1.94	2.28

**REPORT OF CCR RULE STABILITY ANALYSES
AEP CLIFTY CREEK POWER PLANT
BOILER SLAG POND DAM AND LANDFILL RUNOFF COLLECTION POND**

February 16, 2016

7.0 CONCLUSIONS

7.1 PE CERTIFICATION

I, Stan Harris, being a Professional Engineer in good standing in the State of Indiana, do hereby certify, to the best of my knowledge, information, and belief that the information contained in this certification is prepared in accordance with the accepted practice of engineering. I certify that pursuant to 40 CFR 257.73(e)(2), the safety factor assessment for the AEP Clifty Creek Power Plant's Boiler Slag Pond Dam and Landfill Runoff Collection Pond demonstrates compliance with the factors of safety specified in 40 CFR 257.73(e)(1)(i) through (iv).

SIGNATURE



DATE

2/16/16

ADDRESS:

Stantec Consulting Services Inc.
11687 Lebanon Road
Cincinnati, Ohio 45241-2012

TELEPHONE:

(513) 842-8200



7.2 GENERAL

The analyses presented herein are based on information gathered (from various sources) using that degree of care and skill ordinarily exercised under similar circumstances by competent members of the engineering profession. Subsurface profiles are generally based on straight-line interpolation between borings and no warranties can be made regarding the continuity of subsurface conditions between the borings.

The boring logs and related information presented in this report depict approximate subsurface conditions only at the specific boring locations noted and at the time of drilling. Conditions at other locations may differ from those occurring at the boring locations. This report may not be applicable if the facility is modified from what is described in this report or if the site conditions are altered. This report may require updating to reflect the different, modified facility specifics and/or the altered site conditions.



**REPORT OF CCR RULE STABILITY ANALYSES
AEP CLIFTY CREEK POWER PLANT
BOILER SLAG POND DAM AND LANDFILL RUNOFF COLLECTION POND**

REFERENCES

February 16, 2016

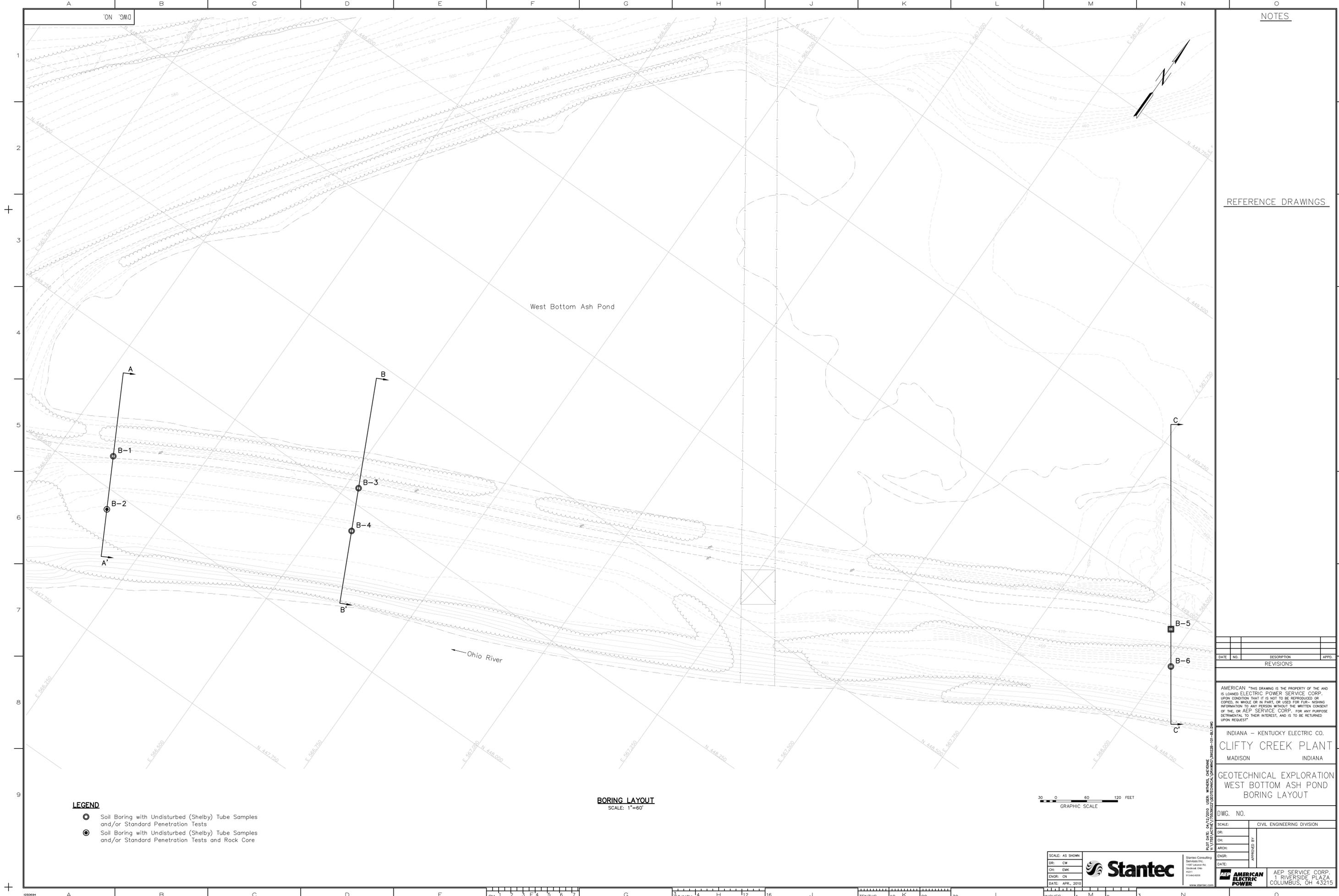
8.0 REFERENCES

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APPENDIX A

SITE PLANS

BOILER SLAG POND DAM



NOTES

REFERENCE DRAWINGS

DATE	NO.	DESCRIPTION	APPR.
REVISIONS			

AMERICAN "THIS DRAWING IS THE PROPERTY OF THE AND IS LOANED ELECTRIC POWER SERVICE CORP. UPON CONDITION THAT IT IS NOT TO BE REPRODUCED OR COPIED, IN WHOLE OR IN PART, OR USED FOR FUR- NISHING INFORMATION TO ANY PERSON WITHOUT THE WRITTEN CONSENT OF THE, OR AEP SERVICE CORP. FOR ANY PURPOSE DETRIMENTAL TO THEIR INTEREST, AND IS TO BE RETURNED UPON REQUEST"

INDIANA - KENTUCKY ELECTRIC CO.
CLIFTY CREEK PLANT
 MADISON INDIANA

GEOTECHNICAL EXPLORATION
 WEST BOTTOM ASH POND
 BORING LAYOUT

DWG. NO. _____
 SCALE: _____
 CIVIL ENGINEERING DIVISION

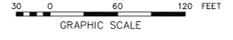
APPROVED BY: _____
 DATE: _____

AMERICAN ELECTRIC POWER
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 1 RIVERSIDE PLAZA
 COLUMBUS, OH 43215

LEGEND

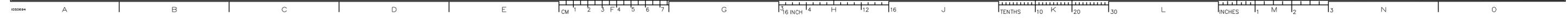
- Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests
- Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests and Rock Core

BORING LAYOUT
 SCALE: 1"=60'

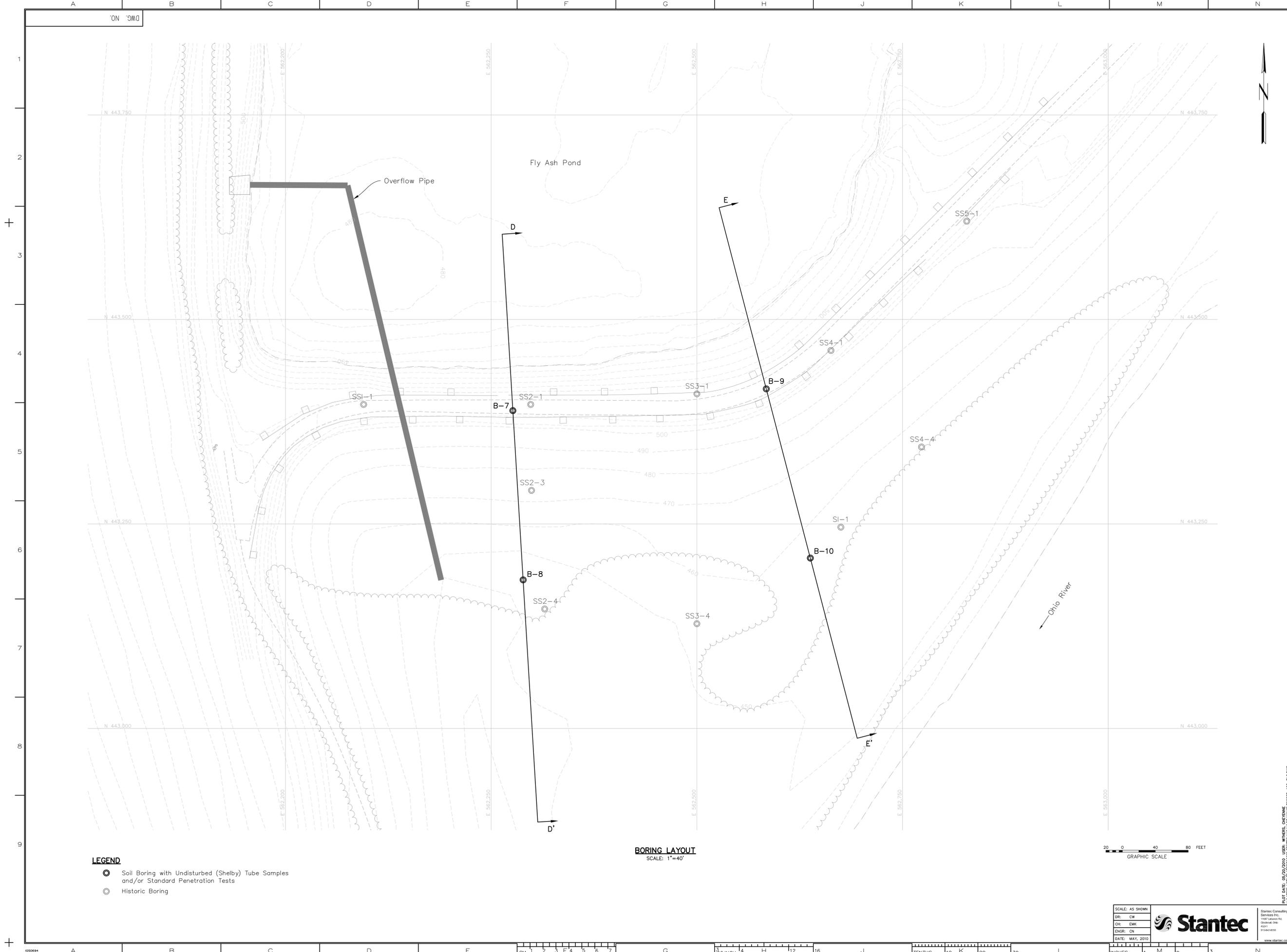


SCALE: AS SHOWN
 DR: CW
 CH: EMK
 ENGR: CN
 DATE: APR., 2010

Stantec Consulting Services Inc.
 10815 Lorain Rd.
 Dayton Ohio 45424
 974-605-0000
 www.stantec.com



LANDFILL RUNOFF COLLECTION POND



NOTES

REFERENCE DRAWINGS

DATE	NO.	DESCRIPTION	APPR.
REVISIONS			

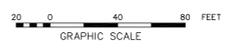
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CLIFTY CREEK PLANT
 MADISON INDIANA
 GEOTECHNICAL EXPLORATION
 LANDFILL RUNOFF
 COLLECTION POND DAM
 BORING LAYOUT

DWG. NO. _____
 SCALE: _____
 CIVIL ENGINEERING DIVISION

APPROVED BY: _____
 DATE: _____
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 COLUMBUS, OH 43215

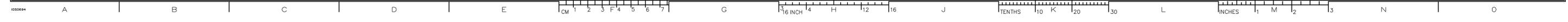
BORING LAYOUT
 SCALE: 1"=40'



- LEGEND**
- Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests
 - Historic Boring

SCALE: AS SHOWN
 DR: CW
 CH: EMK
 ENGR: CN
 DATE: MAY, 2010

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APPENDIX B

BORING LOGS

BOILER SLAG POND DAM

Project Number <u>175539022</u>		Location <u>West Crest: West Pond Dam</u>	
Project Name <u>AEP Clifty Creek / Ash Ponds</u>		Boring No. <u>B-1</u>	Total Depth <u>71.5 ft</u>
County <u>Jefferson, IN</u>		Surface Elevation <u>473.4 ft</u>	
Project Type <u>Geotechnical Exploration</u>		Date Started <u>11/3/09</u>	Completed <u>11/4/09</u>
Supervisor <u>C. Nisingizwe</u> Driller <u>M. Wethington</u>		Depth to Water <u>40.0 ft</u>	Date/Time <u>11/4/09</u>
Logged By <u>C. Nisingizwe</u>		Depth to Water <u>39.2 ft</u>	Date/Time <u>11/13/09</u>

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
473.4'	0.0'	Top of Hole							
		Lean Clay With Sand, light yellowish brown with light gray, damp to moist, medium stiff to very stiff, Fill		SPT-1	2.5 - 4.0	1.2	6-5-6	17	N = 11
				SPT-2	5.0 - 6.5	1.3	5-5-5	15	N = 10
				ST-3	7.5 - 9.5	2.0		23	
				SPT-4	10.0 - 11.5	0.4	1-5-5	21	N = 10
				SPT-5	12.5 - 14.0	1.3	2-2-5	17	N = 7
				ST-6	15.0 - 17.0	2.0		20	
				SPT-7	17.5 - 19.0	1.5	5-6-9	19	N = 15
				SPT-8	20.0 - 21.5	1.5	3-5-10	15	N = 15
				SPT-9	22.5 - 24.0	1.5	3-7-7	17	N = 14
				SPT-10	25.0 - 26.5	1.2	3-3-5	17	N = 8
				SPT-11	27.5 - 29.0	1.3	3-4-8	20	N = 12
				SPT-12	30.0 - 31.5	1.4	4-4-7	19	N = 11
				SPT-13	32.5 - 34.0	1.3	2-4-5	18	N = 9
				SPT-14	35.0 - 36.5	1.1	2-5-5	17	N = 10
435.9'	37.5'				SPT-15	37.5 - 39.0	1.2	1-2-4	20	N = 6

STANTEC/FMSM_LEGACY_175539022 CLIFTY CREEK.GPJ FMSM-GRAPHIC LOG.GDT 5/20/10

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
		Lean Clay With Sand, light yellowish brown with light gray, moist to wet, very soft to medium stiff <i>(Continued)</i>		SPT-16	40.0 - 41.5	1.3	1-2-3	24	N = 5
				ST-17	42.5 - 44.5	2.0		22	
				SPT-18	45.0 - 46.5	1.5	1-1-1	30	N = 2
				SPT-19	47.5 - 49.0	1.5	1-1-2	23	N = 3
				SPT-20	50.0 - 51.5	1.1	1-1-3	28	N = 4
				SPT-21	52.5 - 54.0	1.5	1-1-1	27	N = 2
				SPT-22	55.0 - 56.5	1.5	1-2-2	25	N = 4
				SPT-23	57.5 - 59.0	1.1	1-1-3	28	N = 4
				SPT-24	60.0 - 61.5	1.4	1-2-3	28	N = 5
				SPT-25	62.5 - 64.0	1.3	1-2-4	37	N = 6
				SPT-26	65.0 - 66.5	1.2	2-2-5	34	N = 7
405.9'	67.5'	Gray, Weathered Shale, Augered		SPT-27	67.5 - 69.0	0.4	50+	14	50+
401.9'	71.5'			SPT-28	70.0 - 71.5	0.3	50+	5	50+
No Refusal / Bottom of Hole									

STANTEC/FNSM_LEGACY 175539022 CLIFTY CREEK.GPJ FNSM-GRAPHIC LOG.GDT 5/20/10

Project Number	175539022	Location	West Toe: West Pond Dam		
Project Name	AEP Clifty Creek / Ash Ponds	Boring No.	B-2	Total Depth	61.0 ft
County	Jefferson, IN	Surface Elevation	444.0 ft		
Project Type	Geotechnical Exploration	Date Started	11/12/09	Completed	11/12/09
Supervisor	C. Nisingizwe Driller M. Wethington	Depth to Water	22.5 ft	Date/Time	11/12/09
Logged By	C. Nisingizwe	Depth to Water	N/A	Date/Time	N/A

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core							RQD	Run	Rec. Ft.	Rec. %	Run Depth
444.0'	0.0'	Top of Hole							
		Lean Clay With Sand, light yellowish brown with gray, moist to wet, soft to very stiff		SPT-1	2.5 - 4.0	1.2	7-8-11	17	N = 19
				SPT-2	5.0 - 6.5	0.6	4-3-4	19	N = 7
				SPT-3	7.5 - 9.0	0.6	3-3-4	24	N = 7
				ST-4	10.0 - 12.0	1.6		22	
				SPT-5	12.5 - 14.0	1.2	2-2-3	25	N = 5
				SPT-6	15.0 - 16.5	1.2	2-2-2	28	N = 4
				SPT-7	17.5 - 19.0	1.5	1-1-1	30	N = 2
				SPT-8	20.0 - 21.5	1.5	1-2-2	32	N = 4
				ST-9	22.5 - 24.5	2.0		29	
				SPT-10	25.0 - 26.5	1.5	2-2-2	29	N = 4
				SPT-11	27.5 - 29.0	0.7	1-4-5	30	N = 9
414.0'	30.0'	Lean Clay With Sand, gray, moist to wet, soft to medium stiff		SPT-12	30.0 - 31.5	1.5	3-3-3	25	N = 6
				SPT-13	32.5 - 34.0	1.5	3-3-3	32	N = 6
				SPT-14	35.0 - 36.5	1.5	1-2-3	33	N = 5
				SPT-15	37.5 - 39.0	1.5	1-2-2	31	N = 4

STANTEC/FNSM_LEGACY 175539022 CLIFTY CREEK.GPJ FNSM-GRAPHIC LOG.GDT 5/20/10

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
		Lean Clay With Sand, gray, moist to wet, soft to medium stiff <i>(Continued)</i>		SPT-16	40.0 - 41.5	1.5	3-3-3	30	N = 6
				ST-17	42.5 - 44.5	1.5		33	
				SPT-18	45.0 - 46.5	1.5	1-1-1	35	N = 2
392.5'	51.5'			SPT-19	50.0 - 51.5	1.5	4-3-3	33	N = 6
		Gravel With Silt And Sand, gray, wet, very dense							
388.5'	55.5'		SPT-20	55.0 - 55.5	0.4	11-50+	10		Began Core N = 50+
		Shale, gray, hard, medium bedded							
383.0'	61.0'			45	5.5	5.5	100	61.0	
Bottom of Hole Top of Rock = 56.0' Elevation (388.0')									

STANTEC/FMSM_LEGACY_175539022_CLIFTY_CREEK.GPJ_FMSM-GRAPHIC.LOG.GDT_5/20/10

Project Number <u>175539022</u>		Location <u>Middle Crest: West Pond Dam</u>	
Project Name <u>AEP Clifty Creek / Ash Ponds</u>		Boring No. <u>B-3</u>	Total Depth <u>71.5 ft</u>
County <u>Jefferson, IN</u>		Surface Elevation <u>471.6 ft</u>	
Project Type <u>Geotechnical Exploration</u>		Date Started <u>11/4/09</u>	Completed <u>11/5/09</u>
Supervisor <u>C. Nisingizwe</u> Driller <u>M. Wethington</u>		Depth to Water <u>40.0 ft</u>	Date/Time <u>11/4/09</u>
Logged By <u>C. Nisingizwe</u>		Depth to Water <u>31.0 ft</u>	Date/Time <u>11/13/09</u>

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core							RQD	Run	Rec. Ft.	Rec. %	Run Depth
471.6'	0.0'	Top of Hole							
		Lean Clay With Sand, light yellowish brown with light gray, damp to moist, stiff to very stiff, Fill		SPT-1	2.5 - 4.0	0.7	4-5-6	15	N = 11
			SPT-2	5.0 - 6.5	1.1	3-4-4	17	N = 8	
			SPT-3	7.5 - 9.0	1.1	3-3-7	16	N = 10	
			ST-4	10.0 - 12.0	2.0		16		
			SPT-5	12.5 - 14.0	1.5	4-4-5	22	N = 9	
			SPT-6	15.0 - 16.5	1.0	3-4-6	17	N = 10	
			SPT-7	17.5 - 19.0	1.3	3-5-7	18	N = 12	
			ST-8	20.0 - 22.0	2.0		18		
			SPT-9	22.5 - 24.0	1.5	3-5-7	17	N = 12	
			SPT-10	25.0 - 26.5	1.3	3-4-5	18	N = 9	
			SPT-11	27.5 - 29.0	1.5	6-7-8	16	N = 15	
			SPT-12	30.0 - 31.5	1.5	5-5-5	18	N = 10	
			SPT-13	32.5 - 34.0	1.5	4-7-10	17	N = 17	
			SPT-14	35.0 - 36.5	1.5	5-7-9	22	N = 16	
434.1'	37.5'				SPT-15	37.5 - 39.0	1.5	5-7-11	20	N = 18

STANTEC/FISM_LEGACY 175539022 CLIFTY CREEK.GPJ FISM-GRAPHIC LOG.GDT 5/20/10

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
400.1'	71.5'	Lean Clay With Sand, gray to light brown, moist to wet, very stiff to very stiff (Continued)		SPT-16	40.0 - 41.5	1.5	1-2-2	24	N = 4
				SPT-17	42.5 - 44.0	1.5	1-2-2	23	N = 4
				SPT-18	45.0 - 46.5	1.3	2-3-3	25	N = 6
				ST-19	47.5 - 49.5	2.0		23	
				SPT-20	50.0 - 51.5	1.5	1-2-2	25	N = 4
				SPT-21	52.5 - 54.0	1.5	1-1-1	25	N = 2
				SPT-22	55.0 - 56.5	1.5	1-2-3	24	N = 5
				SPT-23	57.5 - 59.0	1.5	1-1-1	40	N = 2
				SPT-24	60.0 - 61.5	1.5	3-4-4	28	N = 8
				SPT-25	62.5 - 64.0	1.5	1-2-4	33	N = 6
				SPT-26	65.0 - 66.5	1.5	1-3-4	34	N = 7
				SPT-27	67.5 - 69.0	1.5	2-4-5	29	N = 9
				SPT-28	70.0 - 71.5	1.5	3-3-5	31	N = 8
No Refusal / Bottom of Hole									

STANTEC/FISM_LEGACY 175539022 CLIFTY CREEK GPR FISM-GRAPHIC LOG.GDT 5/20/10

Project Number		175539022		Location		Middle Toe: West Pond Dam				
Project Name		AEP Clifty Creek / Ash Ponds		Boring No.		B-4		Total Depth		71.5 ft
County		Jefferson, IN		Surface Elevation		444.0 ft				
Project Type		Geotechnical Exploration		Date Started		11/10/09		Completed		11/11/09
Supervisor		C. Nisingizwe Driller M. Wethington		Depth to Water		22.5 ft		Date/Time		11/10/09
Logged By		C. Nisingizwe		Depth to Water		16.0 ft		Date/Time		11/13/09
Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks	
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth		
444.0'	0.0'	Top of Hole								
		Lean Clay With Sand, brown to dark gray, damp to moist, medium stiff to very stiff		SPT-1	2.5 - 4.0	1.3	8-8-8	14	N = 16	
				SPT-2	5.0 - 6.5	1.4	6-7-8	16	N = 15	
				ST-3	7.5 - 9.5	2.0		--		
				SPT-4	10.0 - 11.5	1.3	3-5-6	19	N = 11	
				SPT-5	12.5 - 14.0	1.0	2-3-4	22	N = 7	
429.0'	15.0'	Lean Clay With Sand, gray, moist to wet, soft to stiff		SPT-6	15.0 - 16.5	1.2	2-2-3	26	N = 5	
				ST-7	17.5 - 19.5	2.0		--		
				SPT-8	20.0 - 21.5	1.5	2-2-2	26	N = 4	
				SPT-9	22.5 - 24.0	1.5	1-2-3	27	N = 5	
				SPT-10	25.0 - 26.5	1.5	2-2-4	26	N = 6	
				SPT-11	27.5 - 29.0	1.5	1-2-3	27	N = 5	
				SPT-12	30.0 - 31.5	1.5	1-1-2	28	N = 3	
				SPT-13	32.5 - 34.0	1.5	1-2-2	35	N = 4	
				SPT-14	35.0 - 36.5	1.5	2-4-5	31	N = 9	
				ST-15	37.5 - 39.5	2.0		--		

STANTEC/FNSM_LEGACY 175539022 CLIFTY CREEK.GPJ FNSM-GRAPHIC LOG.GDT 5/20/10

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
386.5'	57.5'	Lean Clay With Sand, gray, moist to wet, soft to stiff <i>(Continued)</i>		SPT-16	40.0 - 41.5	1.5	2-2-2	24	N = 4
				SPT-17	42.5 - 44.0	1.2	1-2-3	33	N = 5
				SPT-18	45.0 - 46.5	1.5	2-4-4	35	N = 8
				SPT-19	47.5 - 49.0	1.2	1-2-4	31	N = 6
				SPT-20	50.0 - 51.5	1.5	2-3-4	31	N = 7
				SPT-21	52.5 - 54.0	1.5	1-2-3	30	N = 5
				SPT-22	55.0 - 56.5	1.5	2-3-4	21	N = 7
372.5'	71.5'	Gravel With Silt And Sand, gray, moist, dense to very dense		SPT-23	57.5 - 59.0	1.5	10-17-22	13	N = 39
				SPT-24	60.0 - 61.5	1.5	16-28-18	9	N = 46
				SPT-25	65.0 - 66.5	0.7	26-50+	12	N = 50+
				SPT-26	70.0 - 71.5	0.7	20-22-30	9	N = 52
No Refusal / Bottom of Hole									

STANTEC/FISM_LEGACY 175539022 CLIFTY CREEK GPJ FISM-GRAPHIC LOG.GDT 5/20/10

Project Number		175539022		Location		East Crest: West Pond Dam				
Project Name		AEP Clifty Creek / Ash Ponds		Boring No.		B-5		Total Depth		71.5 ft
County		Jefferson, IN		Surface Elevation		468.7 ft				
Project Type		Geotechnical Exploration		Date Started		11/10/09		Completed		11/10/09
Supervisor		C. Nisingizwe Driller M. Wethington		Depth to Water		45.0 ft		Date/Time		11/10/09
Logged By		C. Nisingizwe		Depth to Water		33.8 ft		Date/Time		11/13/09
Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks	
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth		
468.7'	0.0'	Top of Hole								
		Lean Clay With Sand, light yellowish brown with light gray, damp to moist, medium stiff to very stiff, Fill		SPT-1	2.5 - 4.0	1.5	6-9-10	15	N = 19	
				SPT-2	5.0 - 6.5	1.5	4-4-5	17	N = 9	
				ST-3	7.5 - 9.5	1.6		17		
				SPT-4	10.0 - 11.5	1.3	6-7-8	23	N = 15	
				SPT-5	12.5 - 14.0	0.0	3-4-6	--	N = 10	
				SPT-6	15.0 - 16.5	1.3	1-3-4	16	N = 7	
				SPT-7	17.5 - 19.0	1.0	5-7-9	16	N = 16	
				SPT-8	20.0 - 21.5	0.6	1-2-5	18	N = 7	
				ST-9	22.5 - 24.5	1.8		19		
				SPT-10	25.0 - 26.5	1.2	2-3-5	22	N = 8	
				SPT-11	27.5 - 29.0	1.4	1-2-5	25	N = 7	
				SPT-12	30.0 - 31.5	1.3	4-5-7	23	N = 12	
				SPT-13	32.5 - 34.0	1.5	2-3-5	19	N = 8	
432.2'	36.5'			SPT-14	35.0 - 36.5	1.5	4-6-10	18	N = 16	
		Lean Clay With Sand, gray, moist, soft		SPT-15	37.5 - 39.0	1.5	2-3-3	21	N = 6	

STANTEC/FISM_LEGACY 175539022 CLIFTY CREEK.GPJ FISM-GRAPHIC LOG.GDT 5/20/10

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
421.2'	47.5'	Lean Clay With Sand, gray, moist, soft (Continued)		SPT-16	40.0 - 41.5	1.3	1-1-2	25	N = 3
				ST-17	42.5 - 44.5	2.0		23	
				SPT-18	45.0 - 46.5	1.5	1-1-3	25	N = 4
397.2'	71.5'	Sandy Silt, light yellowish brown to gray, wet, soft to stiff		SPT-19	47.5 - 49.0	1.5	1-1-3	28	N = 4
				SPT-20	50.0 - 51.5	1.5	1-1-5	24	N = 6
				SPT-21	52.5 - 54.0	1.0	1-1-1	22	N = 2
				SPT-22	55.0 - 56.5	1.3	1-2-2	23	N = 4
				SPT-23	57.5 - 59.0	1.5	1-2-3	26	N = 5
				SPT-24	60.0 - 61.5	1.5	2-3-4	22	N = 7
				SPT-25	62.5 - 64.0	1.5	2-3-6	27	N = 9
				SPT-26	65.0 - 66.5	1.5	2-5-6	28	N = 11
				SPT-27	67.5 - 69.0	1.5	2-4-5	28	N = 9
				SPT-28	70.0 - 71.5	1.5	3-5-8	30	N = 13
No Refusal / Bottom of Hole									

STANTEC/FISM_LEGACY 175539022 CLIFTY CREEK GPR FISM-GRAPHIC LOG.GDT 5/20/10

Project Number		175539022		Location		East Toe: West Pond Dam				
Project Name		AEP Clifty Creek / Ash Ponds		Boring No.		B-6		Total Depth		71.5 ft
County		Jefferson, IN		Surface Elevation		445.5 ft				
Project Type		Geotechnical Exploration		Date Started		11/19/09		Completed		11/19/09
Supervisor		C. Nisingizwe Driller Danny Jessie		Depth to Water		30.0 ft		Date/Time		11/19/09
Logged By		C. Nisingizwe		Depth to Water		N/A		Date/Time		N/A

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core							RQD	Run	Rec. Ft.	Rec. %	Run Depth
445.5'	0.0'	Top of Hole							
		Lean Clay With Sand, brown to gray, damp to moist, stiff to very stiff		SPT-1	2.5 - 4.0	1.0	2-4-4	19	N = 8
				SPT-2	5.0 - 6.5	1.0	4-4-6	18	N = 10
				ST-3	7.5 - 9.5	2.0		25	
				SPT-4	10.0 - 11.5	1.2	5-7-11	16	N = 18
				SPT-5	12.5 - 14.0	1.1	2-2-2	21	N = 4
				SPT-6	15.0 - 16.5	1.3	1-1-2	31	N = 3
				ST-7	17.5 - 19.5	1.2		32	
				SPT-8	20.0 - 21.5	1.5	0-1-0	32	N = 1
				SPT-9	22.5 - 24.0	1.5	0-0-2	29	N = 2
				SPT-10	25.0 - 26.5	1.5	2-1-3	29	N = 4
418.0'	27.5'	Sandy Silt, gray, moist to wet, very soft to stiff		SPT-11	27.5 - 29.0	1.5	0-3-2	32	N = 5
				SPT-12	30.0 - 31.5	1.5	0-0-3	32	N = 3
				SPT-13	32.5 - 34.0	1.5	0-1-2	33	N = 3
				SPT-14	35.0 - 36.5	1.5	0-0-1	35	N = 1
				SPT-15	37.5 - 39.0	1.5	0-0-1	30	N = 1

STANTEC/FNSM_LEGACY 175539022 CLIFTY CREEK.GPJ FNSM-GRAPHIC.LOG.GDT 5/20/10

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
		Sandy Silt, gray, moist to wet, very soft to stiff <i>(Continued)</i>		ST-16	40.0 - 42.0	1.1		31	
				SPT-17	42.5 - 44.0	1.5	0-1-1	35	N = 2
				SPT-18	45.0 - 46.5	1.5	0-0-1	40	N = 1
				SPT-19	47.5 - 49.0	1.5	0-0-1	40	N = 1
				SPT-20	50.0 - 51.5	1.5	0-2-3	39	N = 5
				SPT-21	52.5 - 54.0	1.5	0-5-6	27	N = 11
				SPT-22	55.0 - 56.5	1.5	4-3-4	31	N = 7
				SPT-23	57.5 - 59.0	1.5	4-4-5	35	N = 9
				SPT-24	60.0 - 61.5	1.5	5-5-6	28	N = 11
				SPT-25	65.0 - 66.5	1.5	4-5-4	28	N = 9
374.0'	71.5'			SPT-26	70.0 - 71.5	0.0	5-5-5	--	N = 10
No Refusal / Bottom of Hole									

STANTEC/FISM_LEGACY 175539022 CLIFTY CREEK GPR FISM-GRAPHIC LOG.GDT 5/20/10

LANDFILL RUNOFF COLLECTION POND:
2009 GEOTECHNICAL EXPLORATION

Project Number	175539022	Location	Crest: LRCP Dam	
Project Name	AEP Clifty Creek / Ash Ponds	Boring No.	B-7	Total Depth 29.0 ft
County	Jefferson, IN	Surface Elevation	503.4 ft	
Project Type	Geotechnical Exploration	Date Started	11/12/09	Completed 11/12/09
Supervisor	C. Nisingizwe Driller M. Wethington	Depth to Water	Dry	Date/Time 11/12/09
Logged By	C. Nisingizwe	Depth to Water	N/A	Date/Time N/A

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
503.4'	0.0'	Top of Hole							
502.9'	0.5'	Asphalt pavement and gravel base							
		Lean Clay, yellow and light gray, moist, stiff							
				ST-1	23.0 - 25.0	2.0		--	
				ST-2	25.0 - 27.0	2.0		20	
				ST-3	27.0 - 29.0	2.0		20	
474.4'	29.0'	No Refusal / Bottom of Hole							

STANTEC/FNSM_LEGACY 175539022 CLIFTY CREEK.GPJ FNSM-GRAPHIC.LOG.GDT 4/16/10

Project Number	175539022	Location	Toe: LRCP Dam	
Project Name	AEP Clifty Creek / Ash Ponds	Boring No.	B-8	Total Depth 31.0 ft
County	Jefferson, IN	Surface Elevation	441.5 ft	
Project Type	Geotechnical Exploration	Date Started	11/19/09	Completed 11/19/09
Supervisor	C. Nisingizwe Driller Danny Jessie	Depth to Water	Dry	Date/Time 11/19/09
Logged By	C. Nisingizwe	Depth to Water	N/A	Date/Time N/A

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
441.5'	0.0'	Top of Hole							
		Silty Clay, yellow and light gray, damp to moist							
425.5'	16.0'								
		Lean Clay, yellowish brown and light gray, moist							
				ST-1	25.0 - 27.0	2.0		25	
				ST-2	27.0 - 29.0	2.0		26	
412.5'	29.0'								
		Lean Clay With Sand, yellowish brown and light gray, moist		ST-3	29.0 - 31.0	2.0		23	
410.5'	31.0'								
		No Refusal / Bottom of Hole							

STANTEC/FNSM_LEGACY 175539022 CLIFTY CREEK.GPJ FNSM-GRAPHIC.LOG.GDT 4/16/10

Project Number	<u>175539022</u>	Location	<u>Crest: LRCP Dam</u>	
Project Name	<u>AEP Clifty Creek / Ash Ponds</u>	Boring No.	<u>B-9</u>	Total Depth <u>22.0 ft</u>
County	<u>Jefferson, IN</u>	Surface Elevation	<u>504.3 ft</u>	
Project Type	<u>Geotechnical Exploration</u>	Date Started	<u>11/12/09</u>	Completed <u>11/12/09</u>
Supervisor	<u>C. Nisingizwe</u> Driller <u>M. Wethington</u>	Depth to Water	<u>Dry</u>	Date/Time <u>11/12/09</u>
Logged By	<u>C. Nisingizwe</u>	Depth to Water	<u>N/A</u>	Date/Time <u>N/A</u>

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core							RQD	Run	Rec. Ft.	Rec. %	Run Depth
504.3'	0.0'	Top of Hole							
503.8'	0.5'	Asphalt pavement and gravel base							
		Lean Clay, yellowish brown and light gray, damp to moist							
				ST-1	16.0 - 18.0	2.0		22	
				ST-2	18.0 - 20.0	2.0		19	
				ST-3	20.0 - 22.0	2.0		20	
482.3'	22.0'								

No Refusal /
Bottom of Hole

STANTEC\FMSM_LEGACY\175539022 CLIFTY CREEK.GPJ FMSM-GRAPHIC LOG.GDT 4/16/10

Project Number	175539022	Location	Toe: LRCP Dam		
Project Name	AEP Clifty Creek / Ash Ponds	Boring No.	B-10	Total Depth	18.0 ft
County	Jefferson, IN	Surface Elevation	457.3 ft		
Project Type	Geotechnical Exploration	Date Started	11/19/09	Completed	11/19/07
Supervisor	C. Nisingizwe Driller Danny Jessie	Depth to Water	Dry	Date/Time	11/19/07
Logged By	C. Nisingizwe	Depth to Water	N/A	Date/Time	N/A

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core							RQD	Run	Rec. Ft.	Rec. %	Run Depth
457.3'	0.0'	Top of Hole							
		Silty Clay With Sand, yellow and light gray, damp to moist							
444.1'	13.2'			ST-1	12.0 - 14.0	1.5		17	
441.3'	16.0'	Silty Sand, gray to brown, damp to moist		ST-2	14.0 - 16.0	2.0		10	
439.3'	18.0'	Silty Clay With Sand, yellow and light gray, damp to moist		ST-3	16.0 - 18.0	2.0		25	

No Refusal /
Bottom of Hole

STANTEC/FNSM_LEGACY 175539022 CLIFTY CREEK.GPJ FNSM-GRAPHIC LOG.GDT 4/16/10

LANDFILL RUNOFF COLLECTION POND:
2015 GEOTECHNICAL EXPLORATION

Project Number	175553022	Location	Landfill Runoff Collection Pond Dam		
Project Name	CCR Rule - AEP Clifty Creek	Boring No.	B-12	Total Depth	101.5 ft
County	Jefferson, IN	Surface Elevation	503.9 (estimated)		
Project Type	Geotechnical Exploration	Date Started	7/6/15	Completed	7/7/15
Supervisor	C. Nisingizwe	Driller	E. Caudill	Depth to Water	60.0 ft
Logged By	C. Nisingizwe	Depth to Water	N/A	Date/Time	7/7/15
		Depth to Water	N/A	Date/Time	N/A

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois. Cont. %	Remarks
Elevation	Depth		Rock Core							RQD	Run	Rec. Ft.	Rec. %	Run Depth
503.9	0.0	Top of Hole							
(estimated)	0.4	Asphalt and base							
		Lean Clay With Sand, gray, damp, medium stiff to stiff		SPT-1	1.0 - 2.5	1.5	1-2-5	21	Pocket Penetrometer (PP) = 2.50 tsf
				SPT-2	5.0 - 6.5	1.5	3-3-4	20	PP = 2.50 tsf
				SPT-3	10.0 - 11.5	1.2	3-4-5	23	PP = 3.50 tsf
				SPT-4	15.0 - 16.5	1.0	3-3-5	19	PP = 2.50 tsf
				SPT-5	20.0 - 21.5	0.9	4-6-9	18	PP = 2.50 tsf
				SPT-6	25.0 - 26.5	1.1	3-5-7	18	PP = 4.25 tsf
				SPT-7	30.0 - 31.5	1.3	2-5-8	19	PP = 4.50 tsf
				SPT-8	35.0 - 36.5	0.9	WOH-3-4	18	PP = 4.00 tsf

STANTEC\FISM_LEGACY_GINT.LOG.GPJ FISM-GRAPHIC.LOG.GDT 8/6/15

Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core							RQD	Run	Rec. Ft.	Rec. %	Run Depth
	40.0	Lean Clay With Sand, gray, damp, medium stiff to stiff <i>(Continued)</i>							
	50.0	Silty Clay With Sand, brown, moist, medium stiff to very stiff		SPT-9	40.0 - 41.5	1.5	6-8-8	16	
			SPT-10	45.0 - 46.5	1.5	1-3-5	19		
	58.0	Silt With Sand, grayish light brown, moist, medium stiff to stiff		SPT-11	50.0 - 51.5	1.5	2-3-3	22	
			SPT-12	55.0 - 56.5	1.0	2-5-8	20		
	63.5	Silty Sand, grayish light brown, damp, very stiff		SPT-13	60.0 - 61.5	1.4	3-11-17	15	
	70.0	Silt With Sand, grayish light brown, wet, stiff		SPT-14	65.0 - 66.5	1.5	2-3-8	28	
	78.0	Sand, mottled gray and brown, moist to wet, medium stiff to stiff		SPT-15	70.0 - 71.5	1.5	3-5-5	22	
			SPT-16	75.0 - 76.5	1.3	2-3-5	28		

STANTECFRSM_LEGACY_GINT.LOG.GPJ FNSM-GRAPHIC.LOG.GDT 8/6/15

Project Number	175553022	Location	Landfill Runoff Collection Pond Dam	
Project Name	CCR Rule - AEP Clifty Creek	Boring No.	B-12	Total Depth 101.5 ft

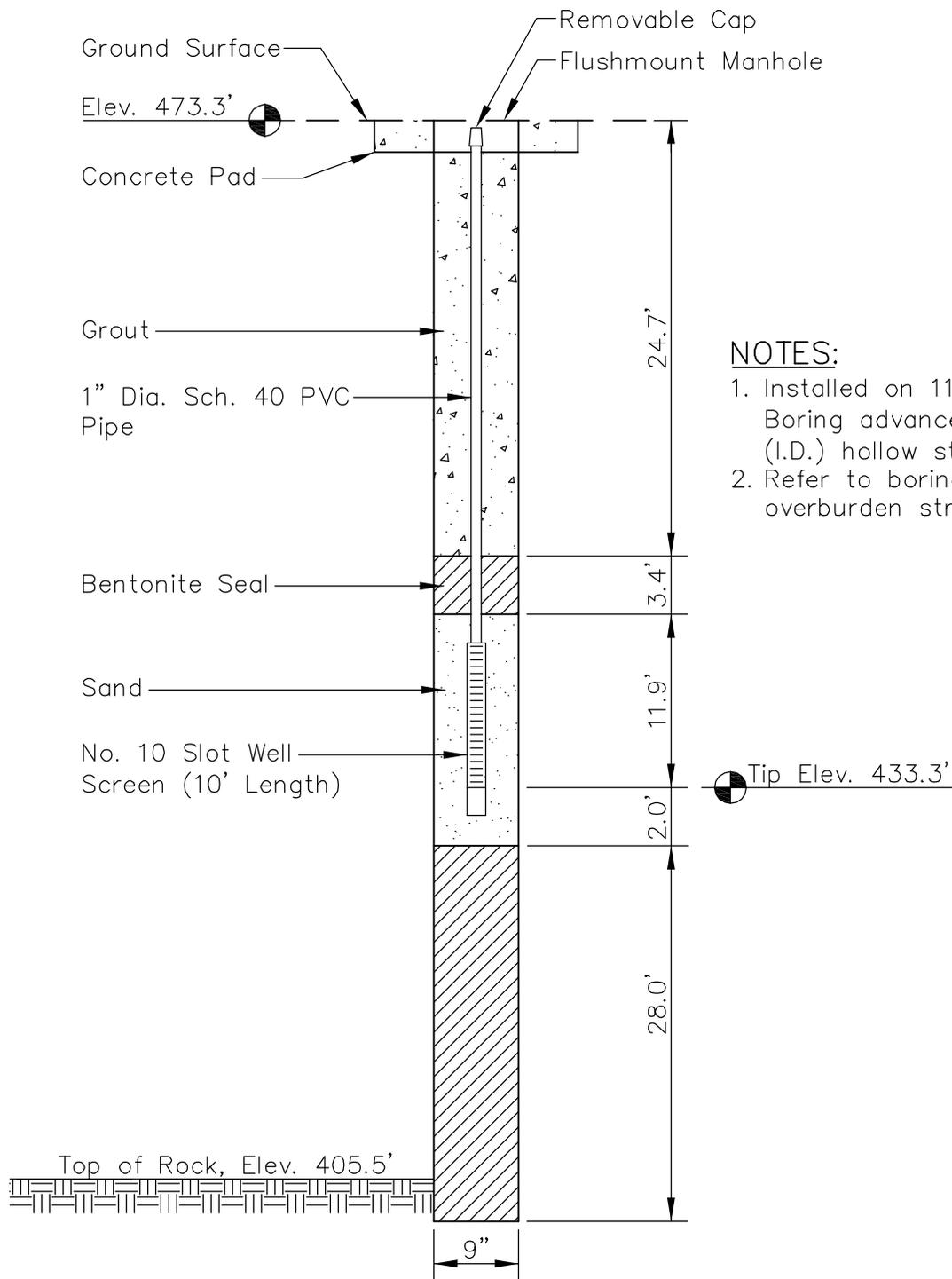
Lithology		Description	Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	Remarks
Elevation	Depth		Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	
		Silt, gray, moist to wet, medium stiff to stiff		SPT-17	80.0 - 81.5	1.5	6-9-6	26	
			SPT-18	85.0 - 86.5	1.5	2-3-5	28		
	90.0	Lean Clay, gray, moist, medium stiff to very stiff		SPT-19	90.0 - 91.5	1.5	2-4-4	25	PP = 2.25 tsf
			SPT-20	95.0 - 96.5	1.5	5-8-11	23	PP = 3.75 tsf	
	101.5		SPT-21	100.0 - 101.5	1.5	4-6-8	27	PP = 3.50 tsf	

No Refusal /
Bottom of Hole

APPENDIX C

PIEZOMETER DETAILS

BOILER SLAG POND DAM



NOTES:

1. Installed on 11/04/2009. Boring advanced with 4.25" (I.D.) hollow stem augers.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 02/18/2010 USER: JENNINGS, MATTHEW V: \\1755\ACTIVE\175539022\GEO\TECHNICAL\DRAWING\INSTRUMENTS\PZB1.DWG

**PIEZOMETER B-1
WEST BOTTOM ASH DAM
CLIFTY CREEK PLANT**

LOCATION:

Northing: 448,055.94
 Easting: 566,098.09
 Ground Elevation: 473.3'

Horizontal Datum: NAD 27
 Vertical Datum: NGVD88

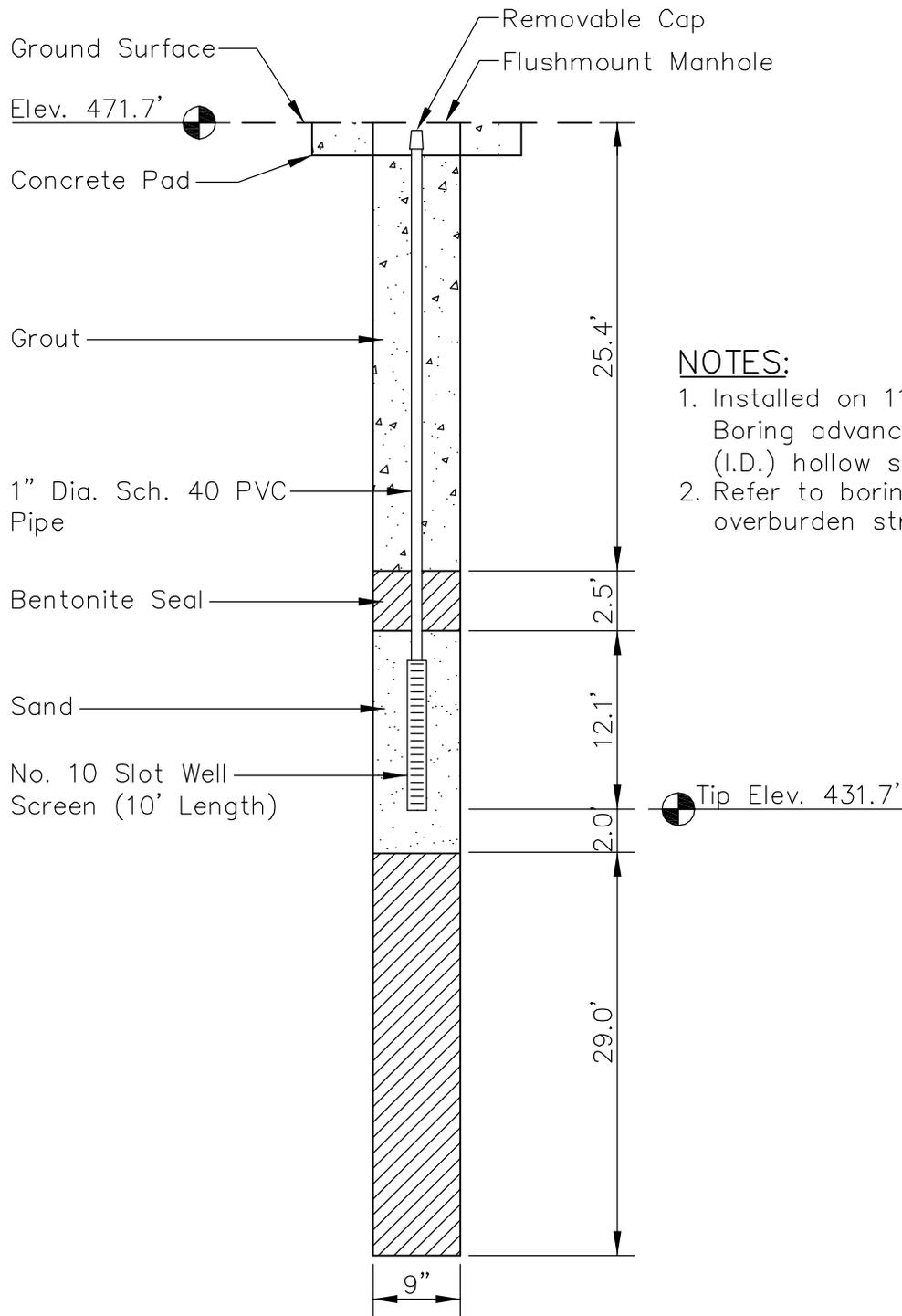


Stantec

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 513-842-8200

www.stantec.com

DRAWN BY	MJ	DATE	FEB., 2010	REVISED		SHEET
CHECKED BY	CN	PROJ. NO.	175539022	1.	3.	1 OF 1
CHECKED BY	EMK	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 11/05/2009. Boring advanced with 4.25" (I.D.) hollow stem augers.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 02/18/2010 USER: JENNINGS, MATTHEW V: 1755\ACTIVE\175539022\GEO\TECHNICAL\DRAWING\INSTRUMENTS\PZB3.DWG

LOCATION:

Northing: 448,278.25
 Easting: 566,522.86
 Ground Elevation: 471.7'

Horizontal Datum: NAD 27
 Vertical Datum: NGVD88

PIEZOMETER B-3
WEST BOTTOM ASH DAM
CLIFTY CREEK PLANT

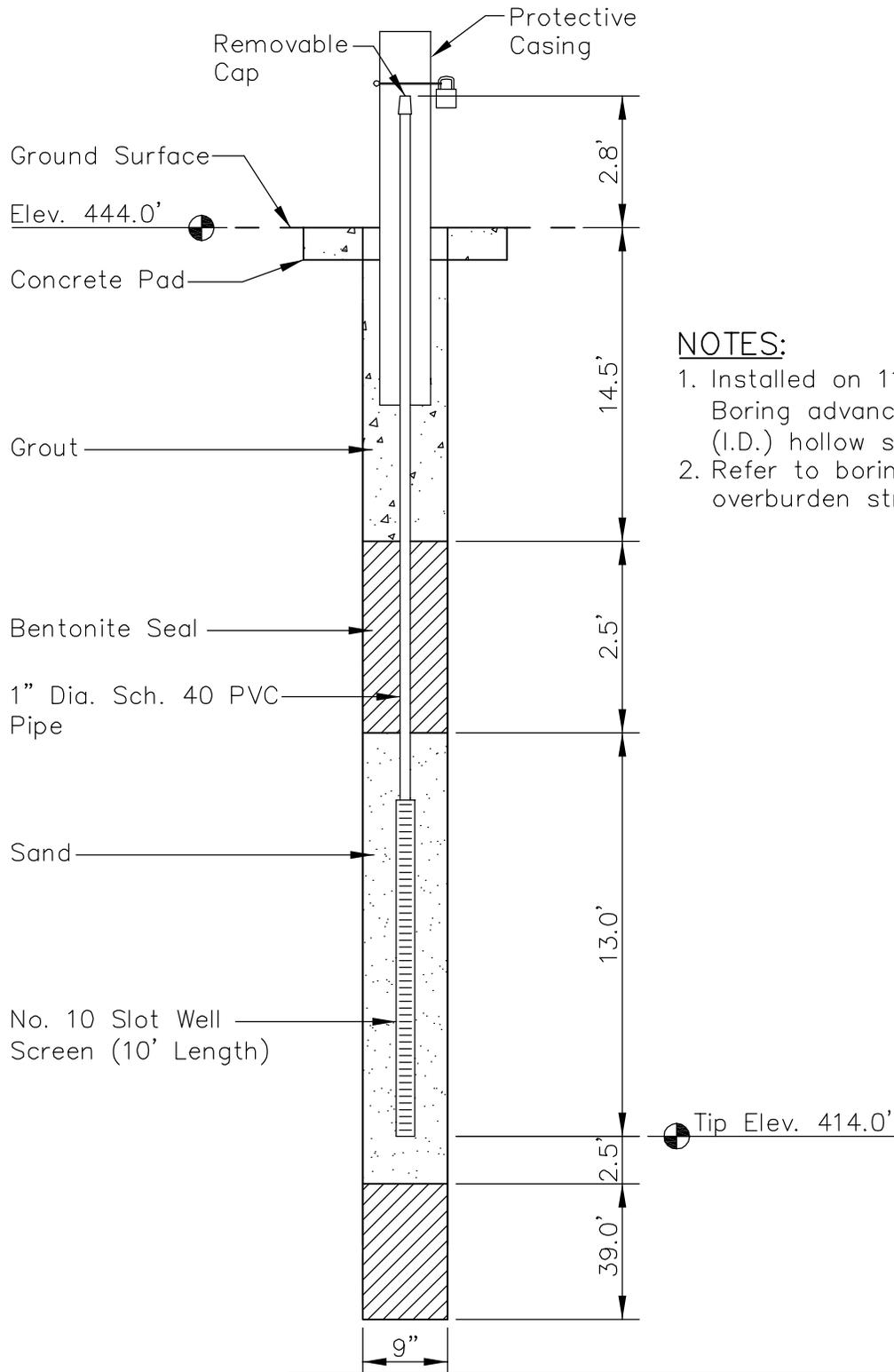


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DRAWN BY	MJ	DATE	FEB., 2010	REVISED		SHEET 1 OF 1
CHECKED BY	CN	PROJ. NO.	175539022	1.	3.	
CHECKED BY	EMK	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 11/11/2009.
Boring advanced with 4.25" (I.D.) hollow stem augers.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 02/18/2010 USER: JENNINGS, MATTHEW V: 1755\ACTIVE\175539022\GEO\TECHNICAL\DRAWING\INSTRUMENTS\PZB4.DWG

**PIEZOMETER B-4
WEST BOTTOM ASH DAM
CLIFTY CREEK PLANT**

LOCATION:

Northing: 448,202.42
Easting: 566,559.67
Ground Elevation: 444.0'

Horizontal Datum: NAD 27
Vertical Datum: NGVD88

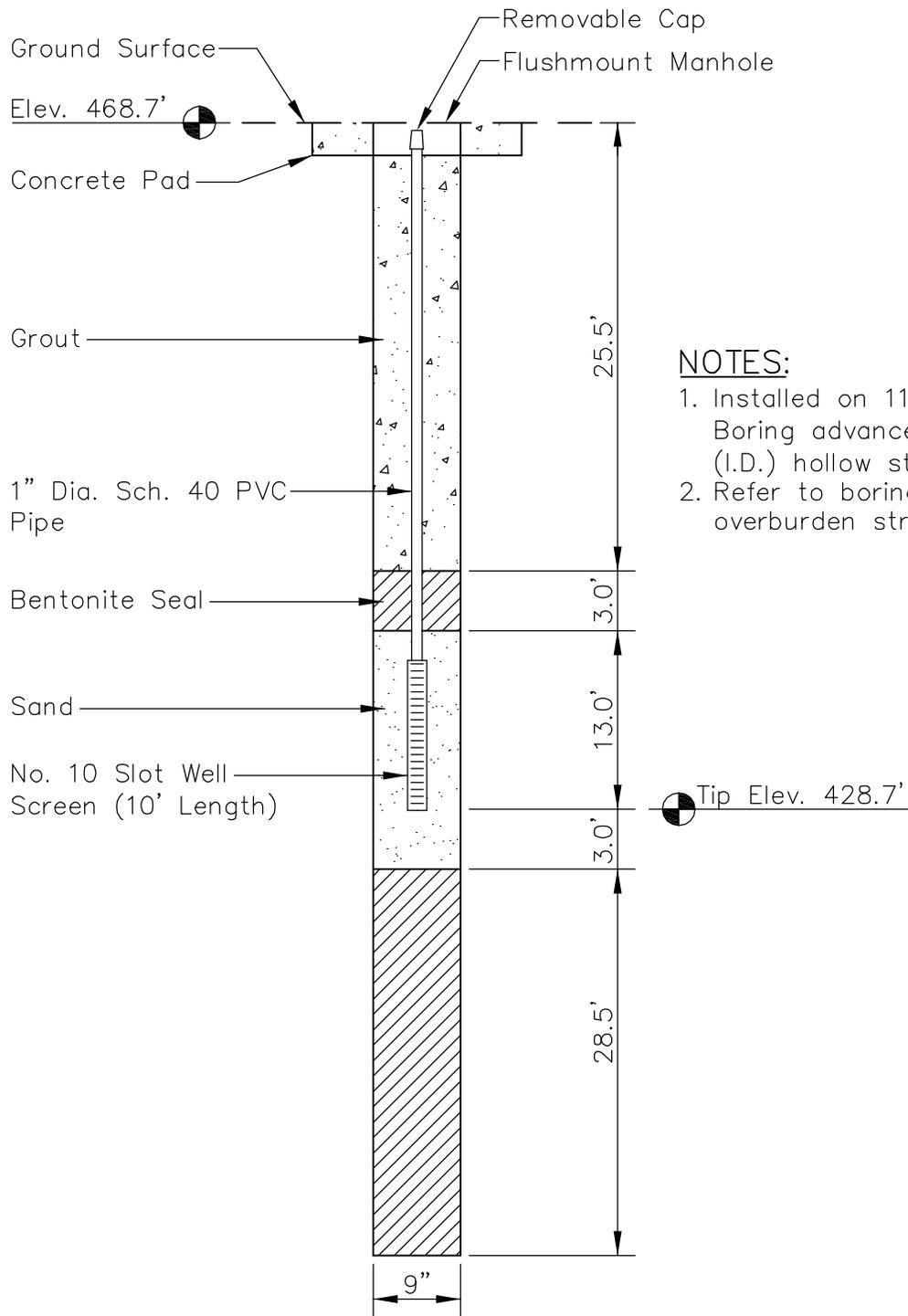


Stantec

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45241-2012
513-842-8200

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DRAWN BY	CW	DATE	FEB., 2010	REVISED		SHEET 1 OF 1
CHECKED BY	CN	PROJ. NO.	175539022	1.	3.	
CHECKED BY	EMK	SCALE	NTS	2.	4.	



NOTES:

1. Installed on 11/10/2009.
Boring advanced with 4.25" (I.D.) hollow stem augers.
2. Refer to boring log for overburden stratigraphy.

PLOT DATE: 02/18/2010 USER: JENNINGS, MATTHEW V: 1755\ACTIVE\175539022\GEO\TECHNICAL\DRAWING\INSTRUMENTS\PZB5.DWG

**PIEZOMETER B-5
WEST BOTTOM ASH DAM
CLIFTY CREEK PLANT**

LOCATION:

Northing: 448,958.53
 Easting: 567,968.94
 Ground Elevation: 468.7'

Horizontal Datum: NAD 27
 Vertical Datum: NGVD88



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**Stantec Consulting
Services Inc.**
 11687 Lebanon Rd.
 Cincinnati, Ohio
 45241-2012
 513-842-8200

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DRAWN BY	MJ	DATE	FEB., 2010	REVISED		SHEET
CHECKED BY	CN	PROJ. NO.	175539022	1.	3.	1 OF 1
CHECKED BY	EMK	SCALE	NTS	2.	4.	

APPENDIX D

SOIL CLASSIFICATION SUMMARIES

BOILER SLAG POND DAM



Summary of Soil Tests

Project Name AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds Project Number 175539022
 Source B-1, 10.0'-11.5', 12.5'-14.0' Lab ID 4
 County Jefferson, IN Date Received 11-16-09
 Sample Type SPT Comp Date Reported 11-30-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
 Moisture Content (%): 19.1

Atterberg Limits

Test Method: ASTM D 4318 Method A
 Prepared: Dry
 Liquid Limit: 32
 Plastic Limit: 19
 Plasticity Index: 13
 Activity Index: 0.54

Particle Size Analysis

Preparation Method: ASTM D 421
 Gradation Method: ASTM D 422
 Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	
3/4"	19	
3/8"	9.5	
No. 4	4.75	100.0
No. 10	2	99.8
No. 40	0.425	98.4
No. 200	0.075	84.0
	0.02	49.1
	0.005	31.1
	0.002	23.7
estimated	0.001	22.1

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	0.2
Coarse Sand	0.2	1.4
Medium Sand	1.4	---
Fine Sand	14.4	14.4
Silt	52.9	60.3
Clay	31.1	23.7

Moisture-Density Relationship

Test Not Performed
 Maximum Dry Density (lb/ft³): N/A
 Maximum Dry Density (kg/m³): N/A
 Optimum Moisture Content (%): N/A
 Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed
 Bearing Ratio (%): N/A
 Compacted Dry Density (lb/ft³): N/A
 Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
 Prepared: Dry
 Particle Size: No. 10
 Specific Gravity at 20° Celsius: 2.70

Classification

Unified Group Symbol: CL
 Group Name: Lean clay with sand
 AASHTO Classification: A-6 (10)

Comments: _____

Project Name AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface Project Number 175539022
 Source B-1, 10.0'-11.5', 12.5'-14.0' Lab ID 4

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
 Prepared using: ASTM D 421

Particle Shape: Angular
 Particle Hardness: Hard and Durable

Tested By: KR
 Test Date: 11-20-2009
 Date Received 11-16-2009

Maximum Particle size: No. 4 Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	
3/4"	
3/8"	
No. 4	100.0
No. 10	99.8

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

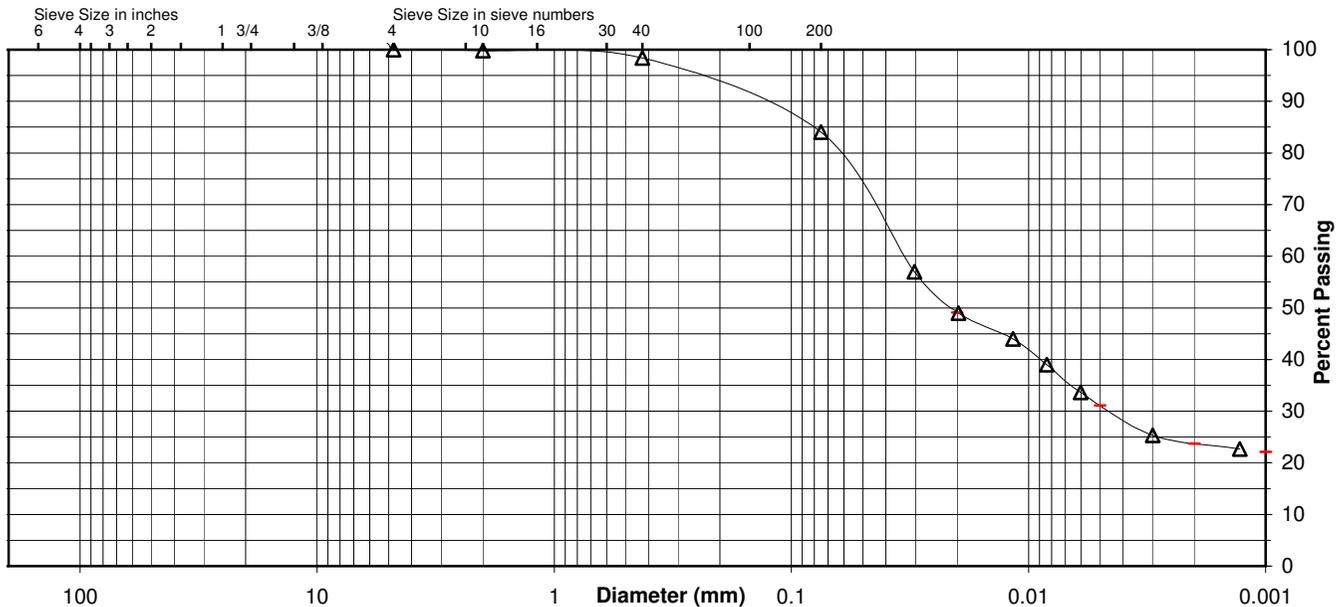
 Specific Gravity 2.7

Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	98.4
No. 200	84.0
0.02 mm	49.1
0.005 mm	31.1
0.002 mm	23.7
0.001 mm	22.1

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.0	0.2	1.4	14.4	52.9	31.1
AASHTO	Gravel		Coarse Sand	Fine Sand	Silt		Clay
	0.2		1.4	14.4	60.3		23.7



Comments _____

Reviewed By _____

Project AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface e:
 Source B-1, 10.0'-11.5', 12.5'-14.0'

Project No. 175539022

Lab ID 4

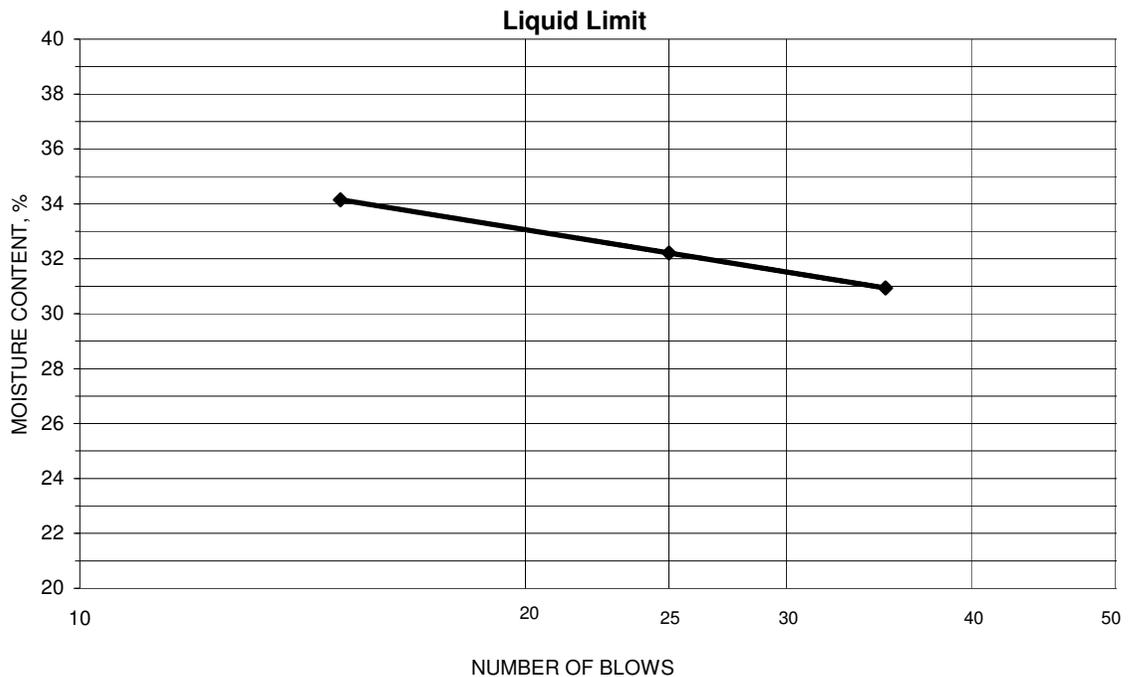
% + No. 40 2

Tested By RG Test Method ASTM D 4318 Method A

Date Received 11-16-2009

Test Date 11-23-2009 Prepared Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
22.20	19.41	11.24	15	34.1	32
20.53	18.13	10.68	25	32.2	
22.58	19.87	11.11	35	30.9	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
24.73	22.56	11.06	18.9	19	13
24.53	22.36	11.08	19.2		

Remarks: _____
 _____ Reviewed By _____



Summary of Soil Tests

Project Name AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds Project Number 175539022
 Source B-1, 47.5'-49.0', 50.0'-51.5' Lab ID 20
 County Jefferson, IN Date Received 11-16-09
 Sample Type SPT Comp Date Reported 11-30-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
 Moisture Content (%): 25.3

Atterberg Limits

Test Method: ASTM D 4318 Method A
 Prepared: Dry
 Liquid Limit: 28
 Plastic Limit: 16
 Plasticity Index: 12
 Activity Index: 0.60

Particle Size Analysis

Preparation Method: ASTM D 421
 Gradation Method: ASTM D 422
 Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	
3/4"	19	
3/8"	9.5	100.0
No. 4	4.75	100.0
No. 10	2	99.9
No. 40	0.425	99.7
No. 200	0.075	84.1
	0.02	54.5
	0.005	28.2
	0.002	20.4
estimated	0.001	17.1

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	0.1
Coarse Sand	0.1	0.2
Medium Sand	0.2	---
Fine Sand	15.6	15.6
Silt	55.9	63.7
Clay	28.2	20.4

Moisture-Density Relationship

Test Not Performed
 Maximum Dry Density (lb/ft³): N/A
 Maximum Dry Density (kg/m³): N/A
 Optimum Moisture Content (%): N/A
 Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed
 Bearing Ratio (%): N/A
 Compacted Dry Density (lb/ft³): N/A
 Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
 Prepared: Dry
 Particle Size: No. 10
 Specific Gravity at 20° Celsius: 2.77

Classification

Unified Group Symbol: CL
 Group Name: Lean clay with sand
 AASHTO Classification: A-6 (8)

Comments: _____

Project Name AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface Project Number 175539022
 Source B-1, 47.5'-49.0', 50.0'-51.5' Lab ID 20

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
 Prepared using: ASTM D 421

Particle Shape: Angular
 Particle Hardness: Hard and Durable

Tested By: KR
 Test Date: 11-20-2009
 Date Received: 11-16-2009

Maximum Particle size: 3/8" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	
3/4"	
3/8"	100.0
No. 4	100.0
No. 10	99.9

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

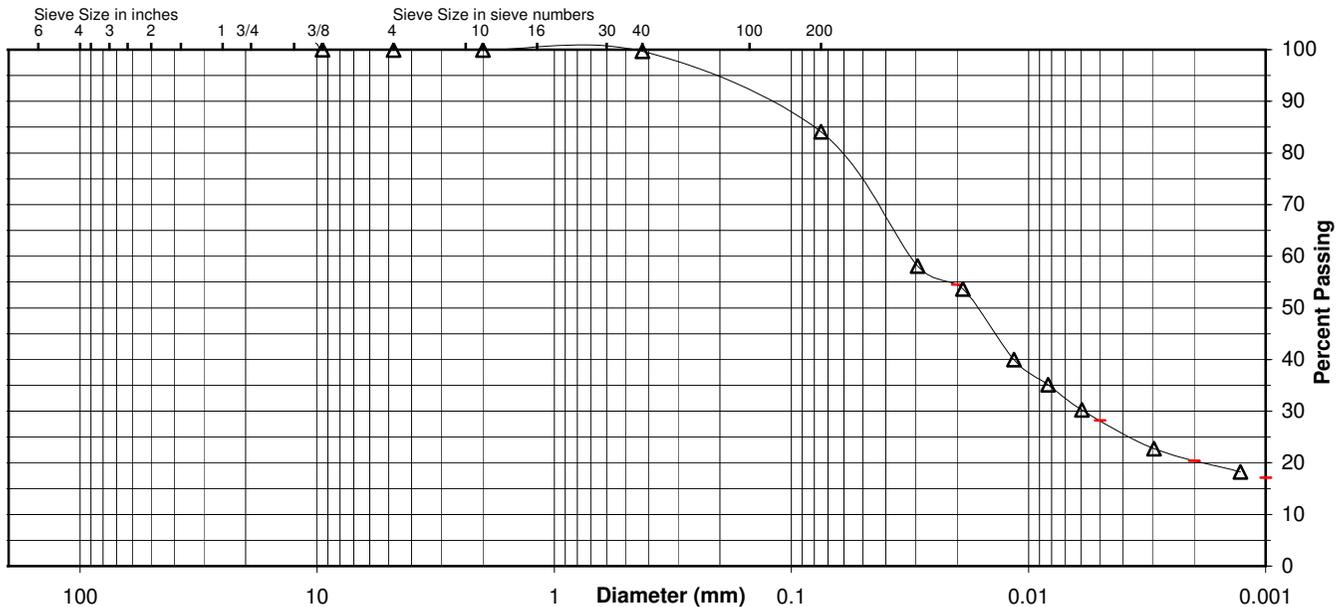
Specific Gravity 2.77

Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	99.7
No. 200	84.1
0.02 mm	54.5
0.005 mm	28.2
0.002 mm	20.4
0.001 mm	17.1

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.0	0.1	0.2	15.6	55.9	28.2
AASHTO	Gravel		Coarse Sand	Fine Sand	Silt		Clay
	0.1		0.2	15.6	63.7		20.4



Comments _____

Reviewed By _____

Project AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface e:
 Source B-1, 47.5'-49.0', 50.0'-51.5'

 Project No. 175539022

 Lab ID 20

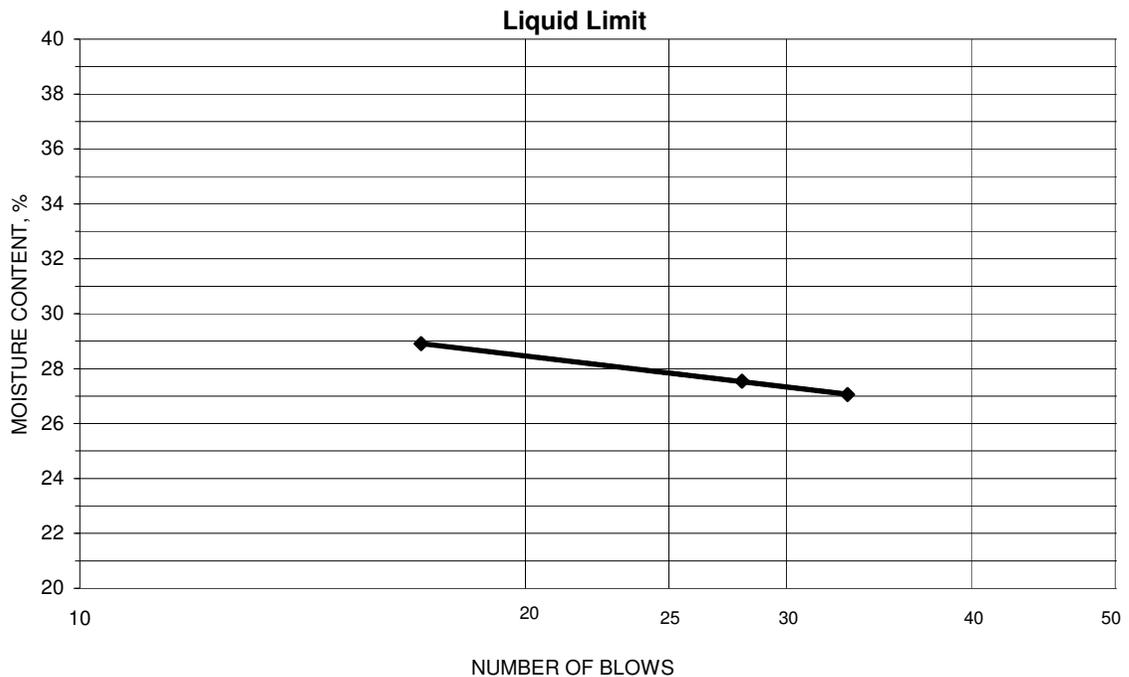
 % + No. 40 0

 Tested By RG Test Method ASTM D 4318 Method A

 Date Received 11-16-2009

 Test Date 11-23-2009 Prepared Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
23.68	21.01	11.14	33	27.1	28
23.20	20.50	11.16	17	28.9	
23.78	21.05	11.14	28	27.5	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
25.05	23.09	10.96	16.2	16	12
22.52	20.86	10.61	16.2		

 Remarks: _____
 _____ Reviewed By _____



Summary of Soil Tests

Project Name AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds Project Number 175539022
 Source B-2, 32.5'-34.0', 35.0'-36.5' Lab ID 43
 County Jefferson, IN Date Received 11-16-09
 Sample Type SPT Comp Date Reported 11-30-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
 Moisture Content (%): 32.1

Atterberg Limits

Test Method: ASTM D 4318 Method A
 Prepared: Dry
 Liquid Limit: 33
 Plastic Limit: 15
 Plasticity Index: 18
 Activity Index: 0.90

Particle Size Analysis

Preparation Method: ASTM D 421
 Gradation Method: ASTM D 422
 Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	
3/4"	19	
3/8"	9.5	100.0
No. 4	4.75	99.7
No. 10	2	99.7
No. 40	0.425	98.7
No. 200	0.075	79.7
	0.02	50.6
	0.005	28.1
	0.002	19.7
estimated	0.001	16.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.3	0.3
Coarse Sand	0.0	1.0
Medium Sand	1.0	---
Fine Sand	19.0	19.0
Silt	51.6	60.0
Clay	28.1	19.7

Moisture-Density Relationship

Test Not Performed
 Maximum Dry Density (lb/ft³): N/A
 Maximum Dry Density (kg/m³): N/A
 Optimum Moisture Content (%): N/A
 Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed
 Bearing Ratio (%): N/A
 Compacted Dry Density (lb/ft³): N/A
 Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
 Prepared: Dry
 Particle Size: No. 10
 Specific Gravity at 20° Celsius: 2.72

Classification

Unified Group Symbol: CL
 Group Name: Lean clay with sand
 AASHTO Classification: A-6 (13)

Comments: _____



Particle-Size Analysis of Soils

ASTM D 422

Project Name AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface Project Number 175539022
 Source B-2, 32.5'-34.0', 35.0'-36.5' Lab ID 43

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
 Prepared using: ASTM D 421
 Particle Shape: Angular
 Particle Hardness: Hard and Durable
 Tested By: KR
 Test Date: 11-20-2009
 Date Received: 11-16-2009

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	
3/4"	
3/8"	100.0
No. 4	99.7
No. 10	99.7

Maximum Particle size: 3/8" Sieve

Analysis for the portion Finer than the No. 10 Sieve

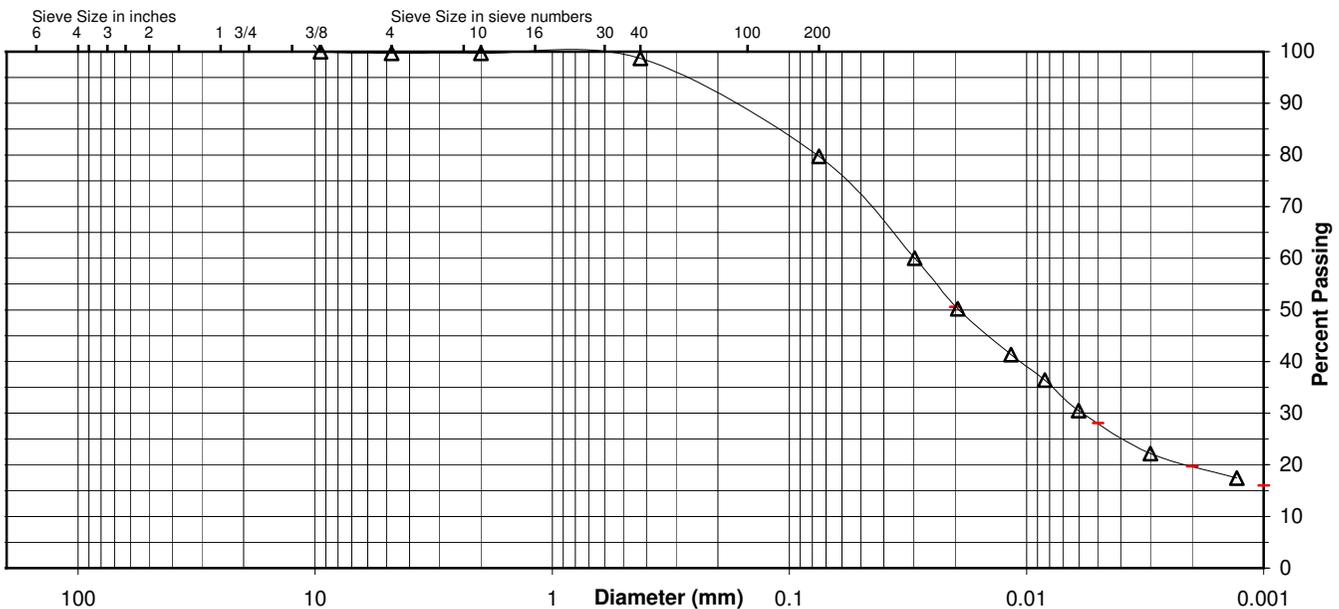
Analysis Based on: Total Sample
 Specific Gravity 2.72

No. 40	98.7
No. 200	79.7
0.02 mm	50.6
0.005 mm	28.1
0.002 mm	19.7
0.001 mm	16.0

Dispersed using: Apparatus A - Mechanical, for 1 minute

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.3	0.0	1.0	19.0	51.6	28.1
AASHTO	Gravel		Coarse Sand		Fine Sand	Silt	Clay
	0.3		1.0		19.0	60.0	19.7



Comments _____

Reviewed By _____

Project AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface e:
 Source B-2, 32.5'-34.0', 35.0'-36.5'

Project No. 175539022

Lab ID 43

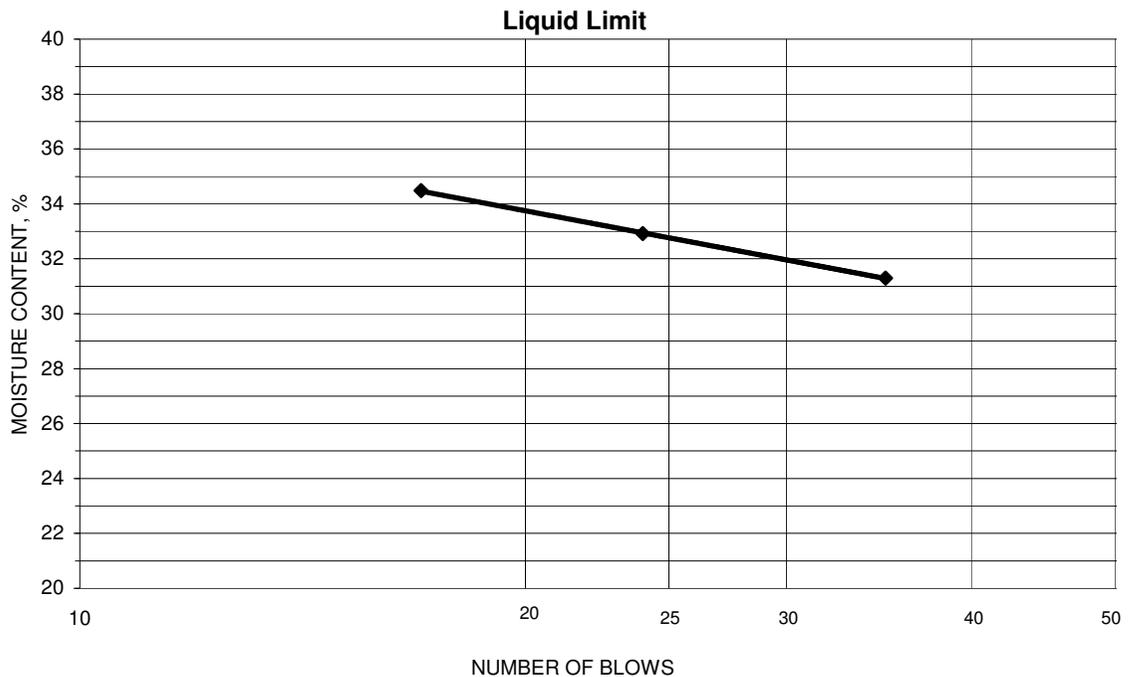
% + No. 40 1

Tested By KR Test Method ASTM D 4318 Method A

Date Received 11-16-2009

Test Date 11-23-2009 Prepared Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
23.26	20.15	11.13	17	34.5	33
23.44	20.29	10.72	24	32.9	
24.86	21.58	11.10	35	31.3	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
21.11	19.78	10.98	15.1	15	18
21.07	19.72	10.97	15.4		

Remarks: _____
 _____ Reviewed By _____



Summary of Soil Tests

Project Name AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds Project Number 175539022
 Source B-4, 20.0'-21.5', 22.5'-24.0' Lab ID 87
 County Jefferson, IN Date Received 11-16-09
 Sample Type SPT Comp Date Reported 11-30-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
 Moisture Content (%): 26.6

Atterberg Limits

Test Method: ASTM D 4318 Method A
 Prepared: Dry
 Liquid Limit: 25
 Plastic Limit: 17
 Plasticity Index: 8
 Activity Index: 0.40

Particle Size Analysis

Preparation Method: ASTM D 421
 Gradation Method: ASTM D 422
 Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	
3/4"	19	
3/8"	9.5	
No. 4	4.75	100.0
No. 10	2	100.0
No. 40	0.425	99.7
No. 200	0.075	80.7
	0.02	52.0
	0.005	27.7
	0.002	19.5
estimated	0.001	15.1

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	0.0
Coarse Sand	0.0	0.3
Medium Sand	0.3	---
Fine Sand	19.0	19.0
Silt	53.0	61.2
Clay	27.7	19.5

Moisture-Density Relationship

Test Not Performed
 Maximum Dry Density (lb/ft³): N/A
 Maximum Dry Density (kg/m³): N/A
 Optimum Moisture Content (%): N/A
 Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed
 Bearing Ratio (%): N/A
 Compacted Dry Density (lb/ft³): N/A
 Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
 Prepared: Dry
 Particle Size: No. 10
 Specific Gravity at 20° Celsius: 2.60

Classification

Unified Group Symbol: CL
 Group Name: Lean clay with sand
 AASHTO Classification: A-4 (4)

Comments: _____



Particle-Size Analysis of Soils

ASTM D 422

Project Name AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface Project Number 175539022
 Source B-4, 20.0'-21.5', 22.5'-24.0' Lab ID 87

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
 Prepared using: ASTM D 421
 Particle Shape: Angular
 Particle Hardness: Hard and Durable
 Tested By: KR
 Test Date: 11-20-2009
 Date Received: 11-16-2009

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	
3/4"	
3/8"	
No. 4	100.0
No. 10	100.0

Maximum Particle size: No. 4 Sieve

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

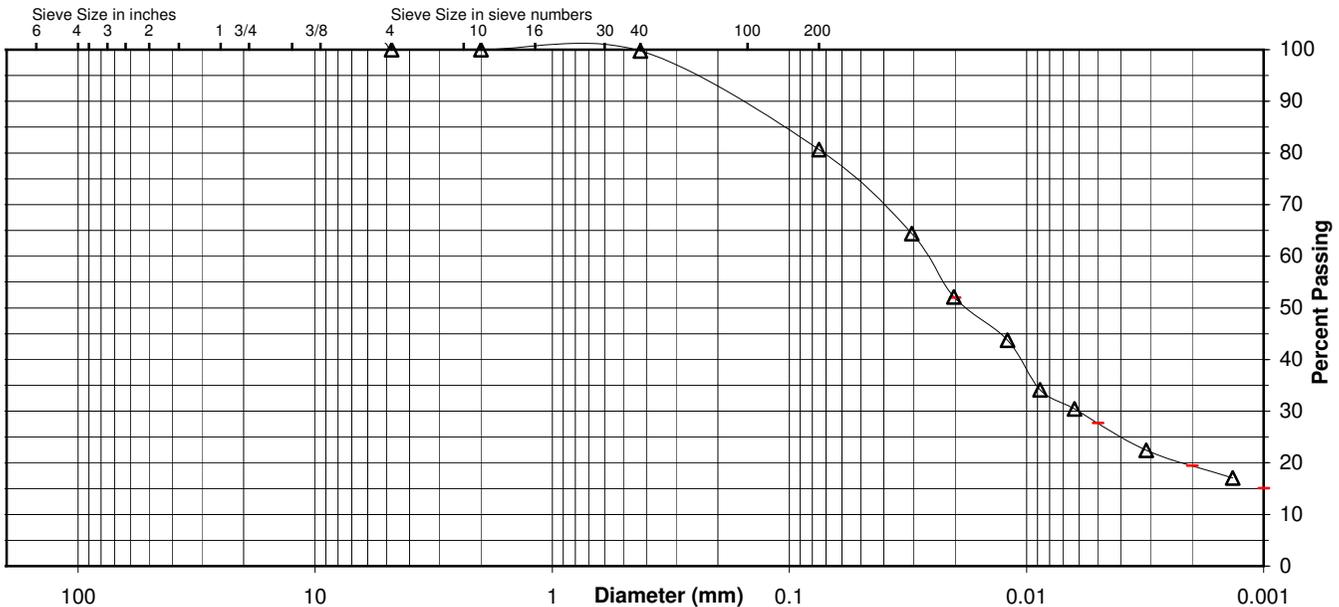
Specific Gravity 2.6

Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	99.7
No. 200	80.7
0.02 mm	52.0
0.005 mm	27.7
0.002 mm	19.5
0.001 mm	15.1

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.0	0.0	0.3	19.0	53.0	27.7
AASHTO	Gravel		Coarse Sand	Fine Sand	Silt		Clay
	0.0		0.3	19.0	61.2		19.5



Comments _____

Reviewed By _____

Project AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface e:
 Source B-4, 20.0'-21.5', 22.5'-24.0'

 Project No. 175539022

 Lab ID 87

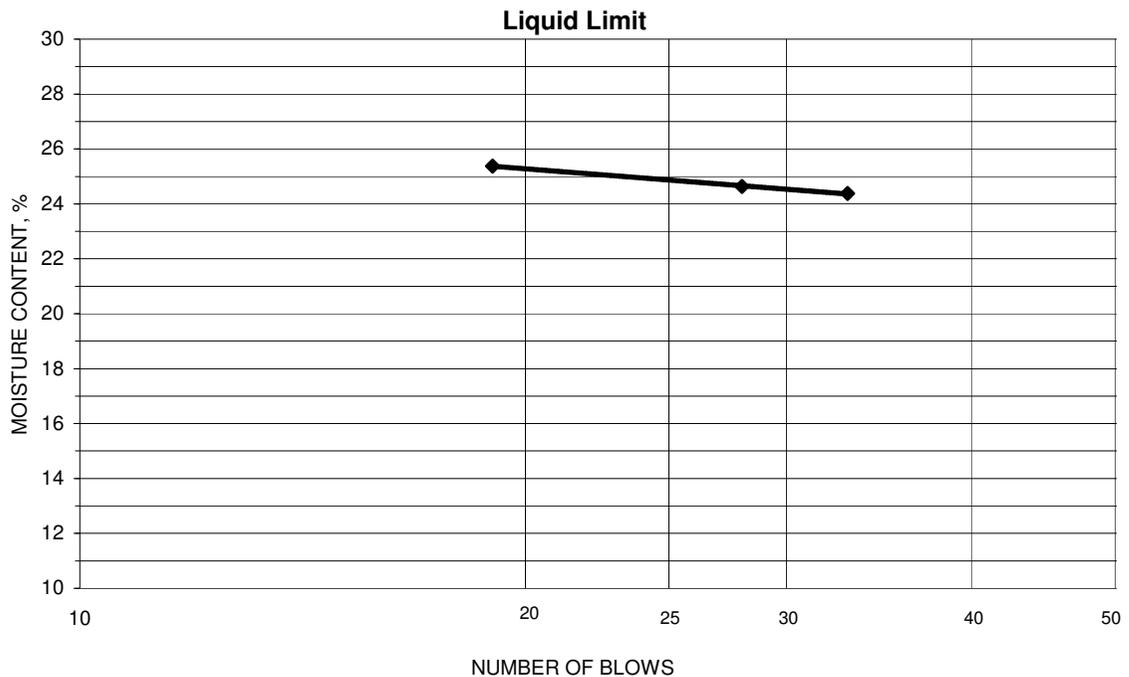
 % + No. 40 0

 Tested By RG Test Method ASTM D 4318 Method A

 Date Received 11-16-2009

 Test Date 11-23-2009 Prepared Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
24.04	21.40	10.57	33	24.4	25
23.55	21.04	11.15	19	25.4	
23.10	20.72	11.06	28	24.6	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
24.08	22.17	11.08	17.2	17	8
25.29	23.10	10.68	17.6		

 Remarks: _____
 _____ Reviewed By _____



Summary of Soil Tests

Project Name AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds Project Number 175539022
 Source B-4, 57.5'-59.0', 60.0'-61.5' Lab ID 103
 County Jefferson, IN Date Received 11-16-09
 Sample Type SPT Comp Date Reported 11-30-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
 Moisture Content (%): 10.9

Atterberg Limits

Test Method: ASTM D 4318 Method A
 Prepared: Dry
 Liquid Limit: ---
 Plastic Limit: Non Plastic
 Plasticity Index: ---
 Activity Index: N/A

Particle Size Analysis

Preparation Method: ASTM D 421
 Gradation Method: ASTM D 422
 Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	100.0
1"	25	97.1
3/4"	19	92.5
3/8"	9.5	72.7
No. 4	4.75	46.1
No. 10	2	32.6
No. 40	0.425	13.6
No. 200	0.075	5.7
	0.02	2.9
	0.005	1.5
	0.002	1.1
estimated	0.001	0.9

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	53.9	67.4
Coarse Sand	13.5	19.0
Medium Sand	19.0	---
Fine Sand	7.9	7.9
Silt	4.2	4.6
Clay	1.5	1.1

Moisture-Density Relationship

Test Not Performed
 Maximum Dry Density (lb/ft³): N/A
 Maximum Dry Density (kg/m³): N/A
 Optimum Moisture Content (%): N/A
 Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed
 Bearing Ratio (%): N/A
 Compacted Dry Density (lb/ft³): N/A
 Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
 Prepared: Dry
 Particle Size: No. 10
 Specific Gravity at 20° Celsius: 2.72

Classification

Unified Group Symbol: GW-GM
 Group Name: Well-graded gravel with silt and sand
 AASHTO Classification: A-1-a (1)

Comments: _____



Particle-Size Analysis of Soils

ASTM D 422

Project Name AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface Project Number 175539022
 Source B-4, 57.5'-59.0', 60.0'-61.5' Lab ID 103

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
 Prepared using: ASTM D 421
 Particle Shape: Angular
 Particle Hardness: Hard and Durable
 Tested By: KR
 Test Date: 11-20-2009
 Date Received: 11-16-2009

Sieve Size	% Passing
3"	
2"	
1 1/2"	100.0
1"	97.1
3/4"	92.5
3/8"	72.7
No. 4	46.1
No. 10	32.6

Maximum Particle size: 1 1/2" Sieve

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

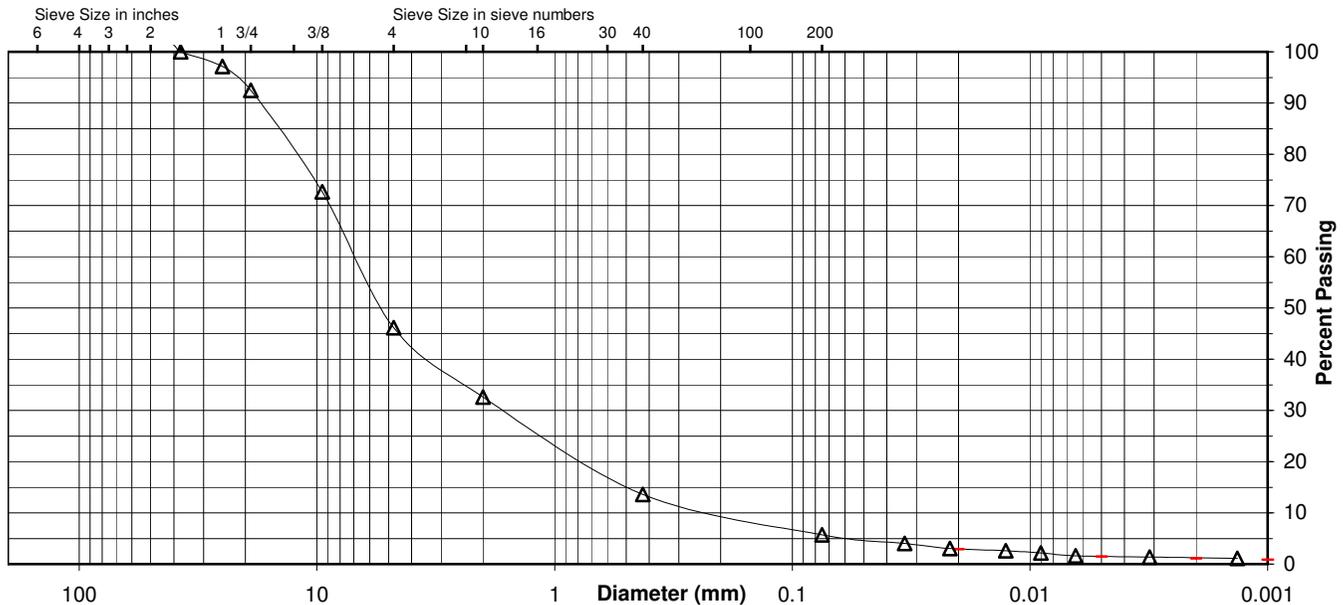
Specific Gravity 2.72

Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	13.6
No. 200	5.7
0.02 mm	2.9
0.005 mm	1.5
0.002 mm	1.1
0.001 mm	0.9

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay	
		7.5	46.4	13.5	19.0	7.9	4.2	1.5
AASHTO	Gravel			Coarse Sand	Fine Sand	Silt		Clay
	67.4			19.0	7.9	4.6		1.1



Comments _____

Reviewed By _____

Project AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface e:
 Source B-4, 57.5'-59.0', 60.0'-61.5'

 Project No. 175539022

 Lab ID 103

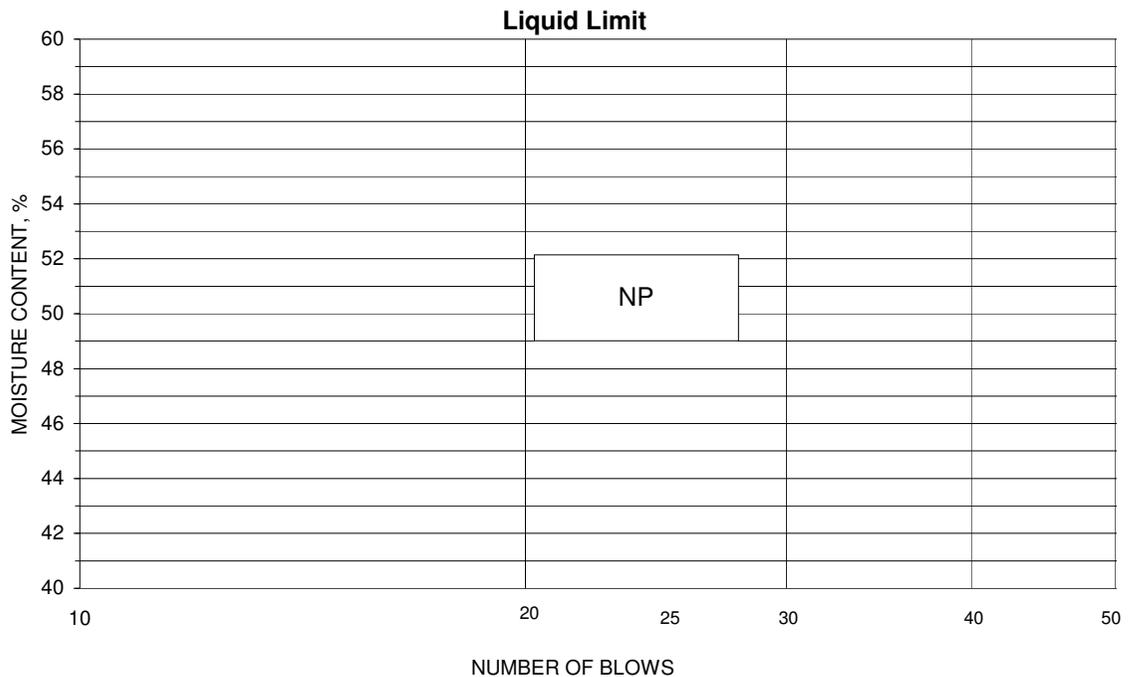
 % + No. 40 86

 Tested By RG Test Method ASTM D 4318 Method A

 Date Received 11-16-2009

 Test Date 11-23-2009 Prepared Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
					#VALUE!



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
					#VALUE!

 Remarks: _____
 _____ Reviewed By _____



Summary of Soil Tests

Project Name AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds Project Number 175539022
 Source B-5, 55.0'-56.5', 57.5'-59.0' Lab ID 129
 County Jefferson, IN Date Received 11-16-09
 Sample Type SPT Comp Date Reported 11-30-09

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
 Moisture Content (%): 24.9

Atterberg Limits

Test Method: ASTM D 4318 Method A
 Prepared: Dry
 Liquid Limit: ---
 Plastic Limit: Non Plastic
 Plasticity Index: ---
 Activity Index: N/A

Particle Size Analysis

Preparation Method: ASTM D 421
 Gradation Method: ASTM D 422
 Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	Passing
3"	75	
2"	50	
1 1/2"	37.5	
1"	25	
3/4"	19	
3/8"	9.5	100.0
No. 4	4.75	100.0
No. 10	2	100.0
No. 40	0.425	99.9
No. 200	0.075	54.0
	0.02	26.2
	0.005	16.7
	0.002	13.0
estimated	0.001	10.5

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	0.0
Coarse Sand	0.0	0.1
Medium Sand	0.1	---
Fine Sand	45.9	45.9
Silt	37.3	41.0
Clay	16.7	13.0

Moisture-Density Relationship

Test Not Performed
 Maximum Dry Density (lb/ft³): N/A
 Maximum Dry Density (kg/m³): N/A
 Optimum Moisture Content (%): N/A
 Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed
 Bearing Ratio (%): N/A
 Compacted Dry Density (lb/ft³): N/A
 Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
 Prepared: Dry
 Particle Size: No. 10
 Specific Gravity at 20° Celsius: 2.74

Classification

Unified Group Symbol: ML
 Group Name: Sandy silt
 AASHTO Classification: A-4 (0)

Comments: _____

Project Name AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface Project Number 175539022
 Source B-5, 55.0'-56.5', 57.5'-59.0' Lab ID 129

Sieve analysis for the Portion Coarser than the No. 10 Sieve

Test Method: ASTM D 422
 Prepared using: ASTM D 421

Particle Shape: Angular
 Particle Hardness: Hard and Durable

Tested By: KR
 Test Date: 11-20-2009
 Date Received: 11-16-2009

Maximum Particle size: 3/8" Sieve

Sieve Size	% Passing
3"	
2"	
1 1/2"	
1"	
3/4"	
3/8"	100.0
No. 4	100.0
No. 10	100.0

Analysis for the portion Finer than the No. 10 Sieve

Analysis Based on: Total Sample

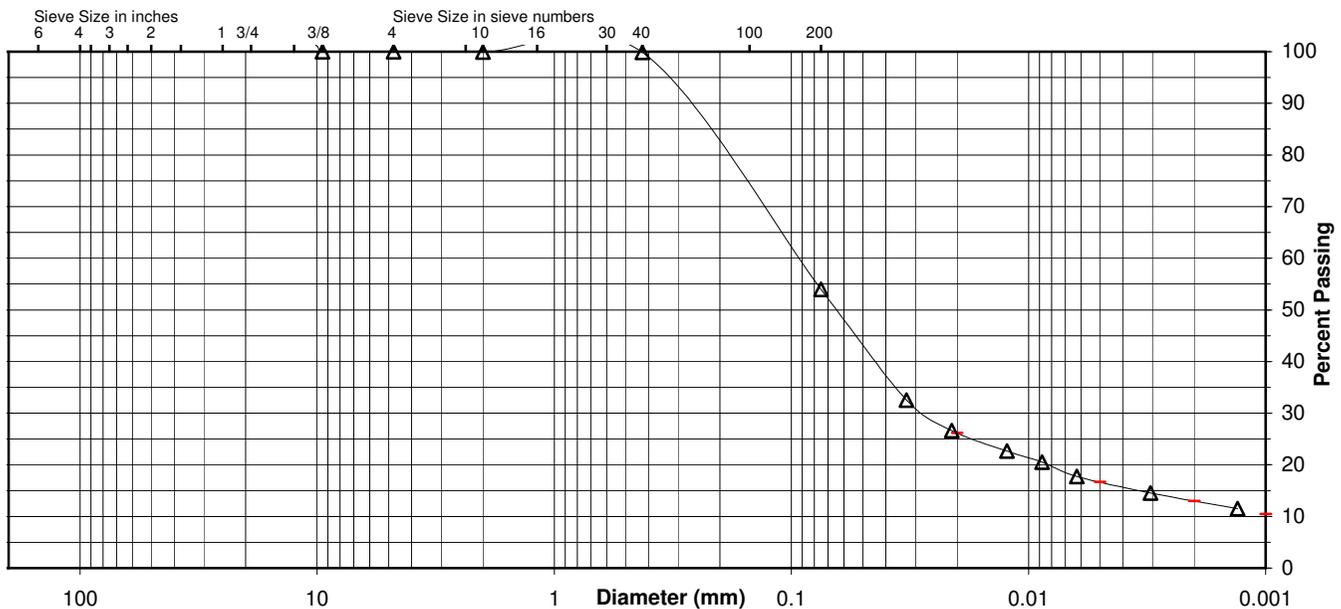
Specific Gravity 2.74

Dispersed using: Apparatus A - Mechanical, for 1 minute

No. 40	99.9
No. 200	54.0
0.02 mm	26.2
0.005 mm	16.7
0.002 mm	13.0
0.001 mm	10.5

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	0.0	0.0	0.0	0.1	45.9	37.3	16.7
AASHTO	Gravel		Coarse Sand		Fine Sand	Silt	Clay
	0.0		0.1		45.9	41.0	13.0



Comments _____

Reviewed By _____

Project AEP - Clifty Creek - West Bottom Ash and Fly Ash Ponds subsurface e:
 Source B-5, 55.0'-56.5', 57.5'-59.0'

 Project No. 175539022

 Lab ID 129

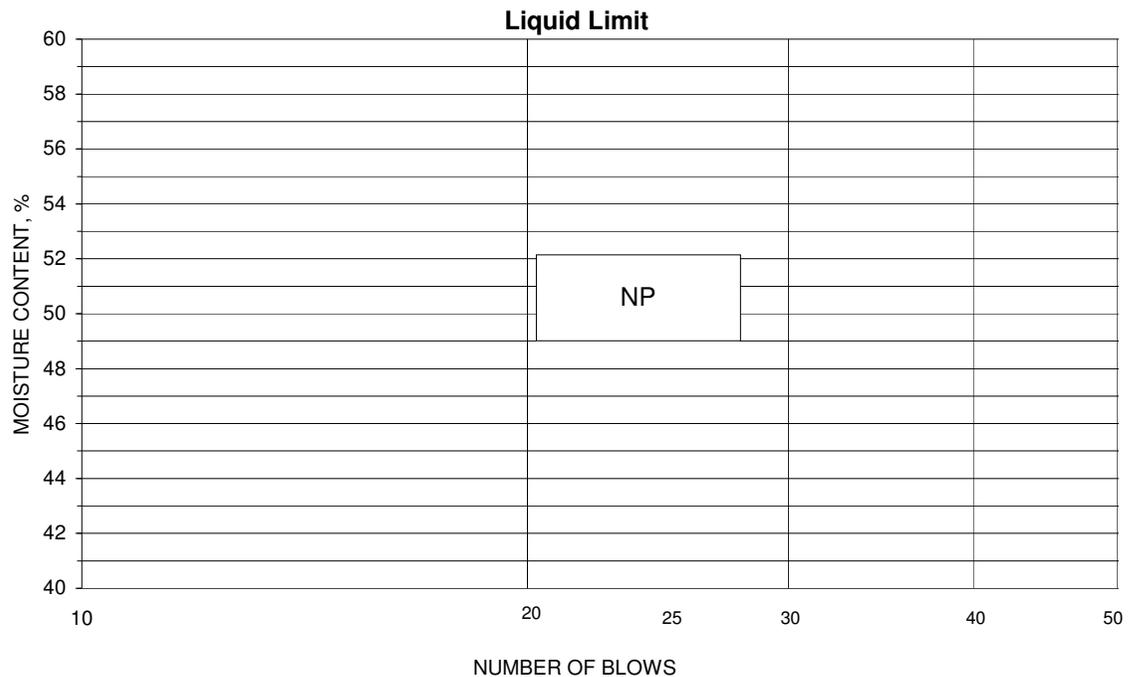
 % + No. 40 0

 Tested By RG Test Method ASTM D 4318 Method A

 Date Received 11-16-2009

 Test Date 11-23-2009 Prepared Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
					#VALUE!



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
					#VALUE!

 Remarks: _____
 _____ Reviewed By _____

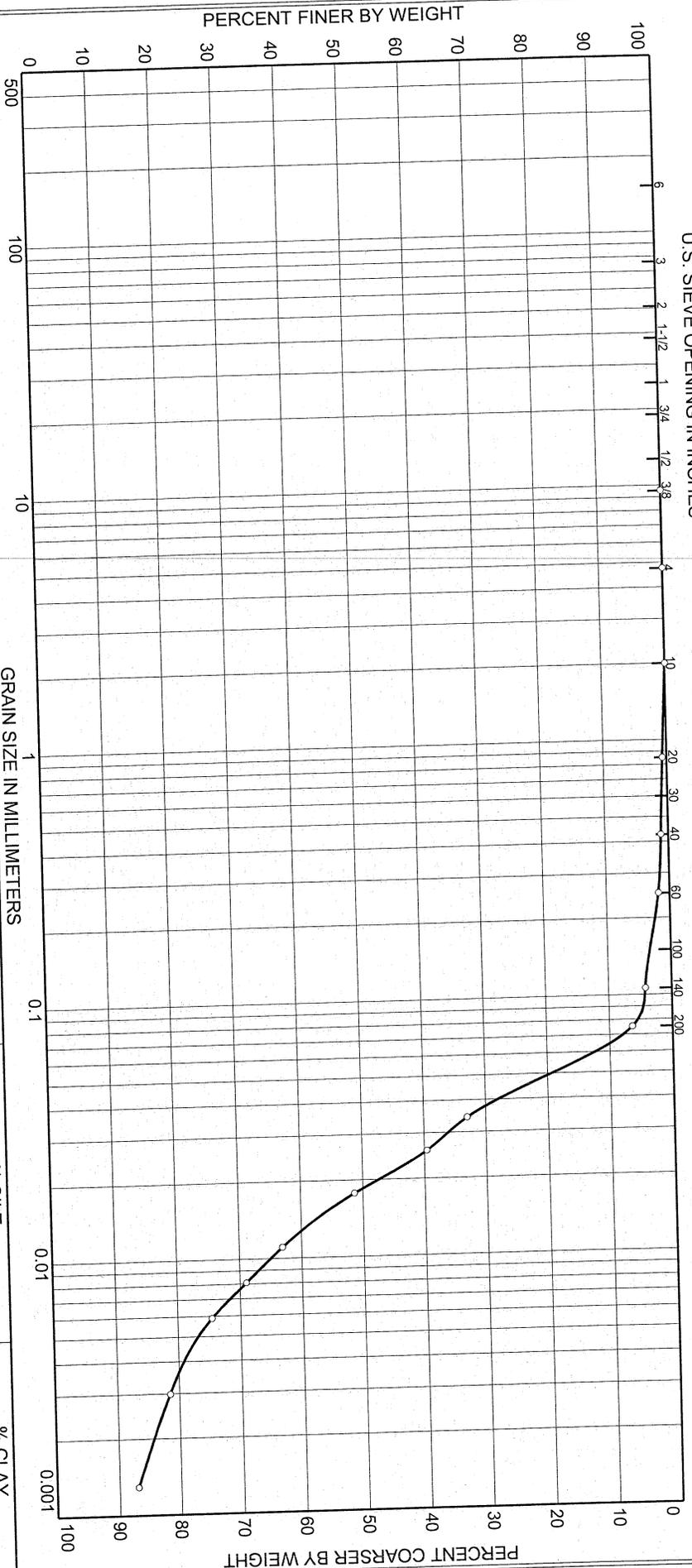
LANDFILL RUNOFF COLLECTION POND:
2009 GEOTECHNICAL EXPLORATION

Particle Size Distribution Report ASTM D422

U.S. SIEVE OPENING IN INCHES

U.S. STANDARD SIEVE NUMBERS

HYDROMETER



PERCENT FINER BY WEIGHT

GRAIN SIZE IN MILLIMETERS

PERCENT COARSER BY WEIGHT

% COBBLES 0.0

% GRAVEL 0.0

% SAND 6.4

% SILT 70.4

% CLAY 23.2

SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PL
	B-7	27.2-27.8 ft	12/10/09	CL	Lean clay		28	20

Client Stantec

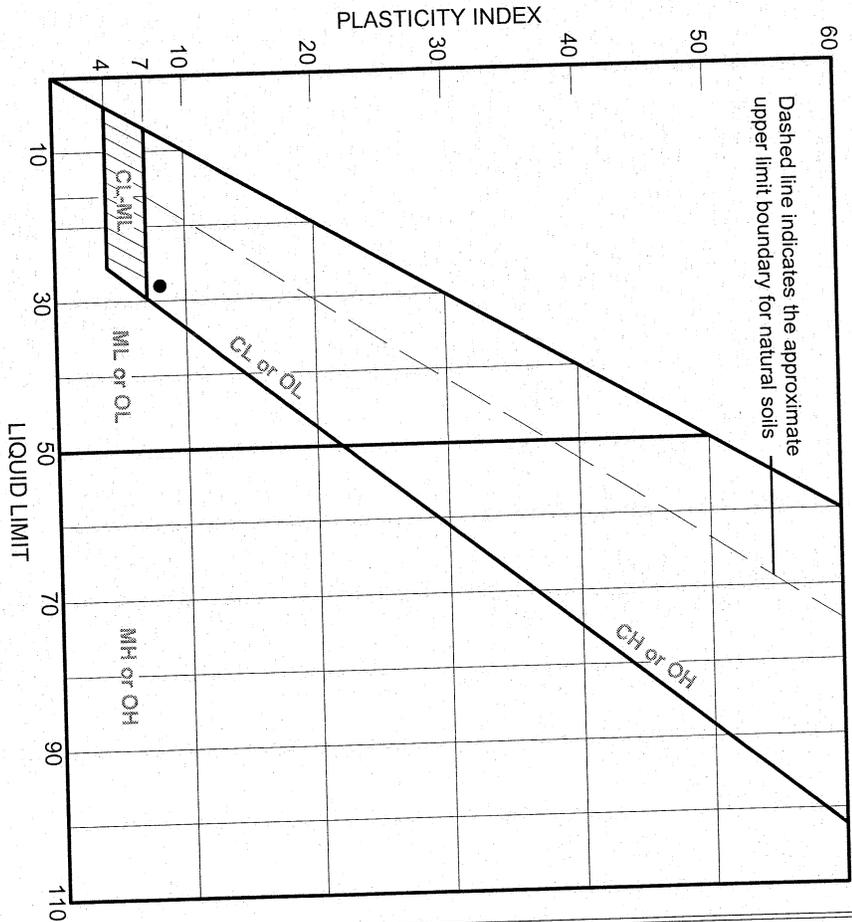
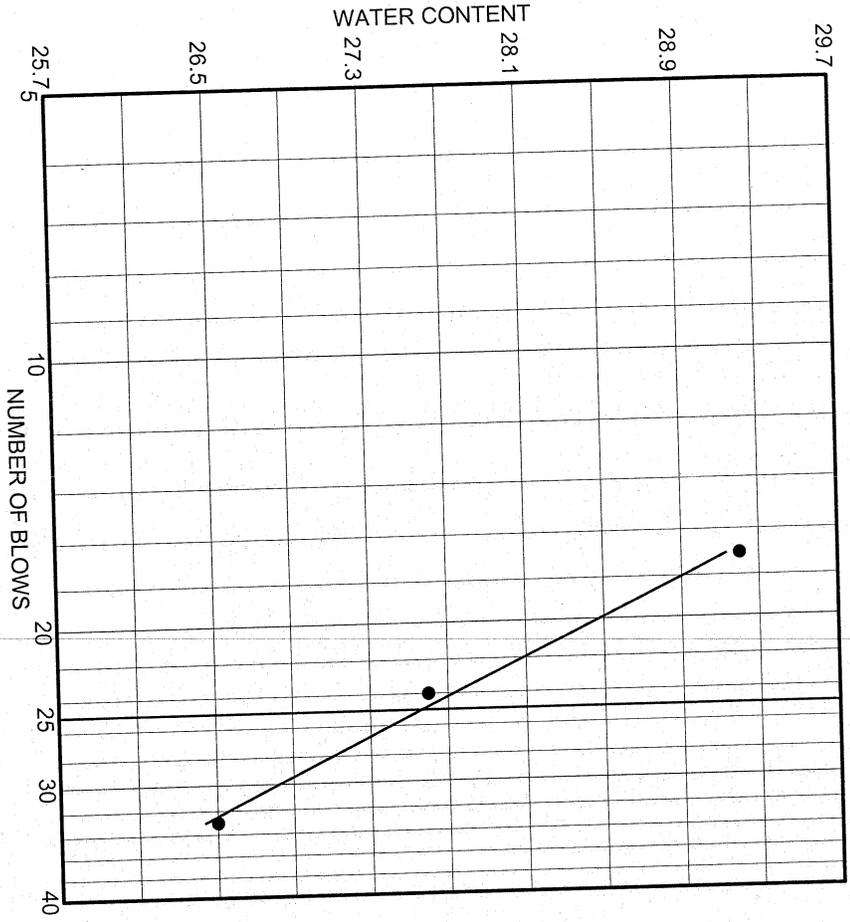
Project Clifty Creek

Project No. GTX-1516

Lab no.

GeoTesting
Express Inc.

LIQUID AND PLASTIC LIMITS TEST REPORT



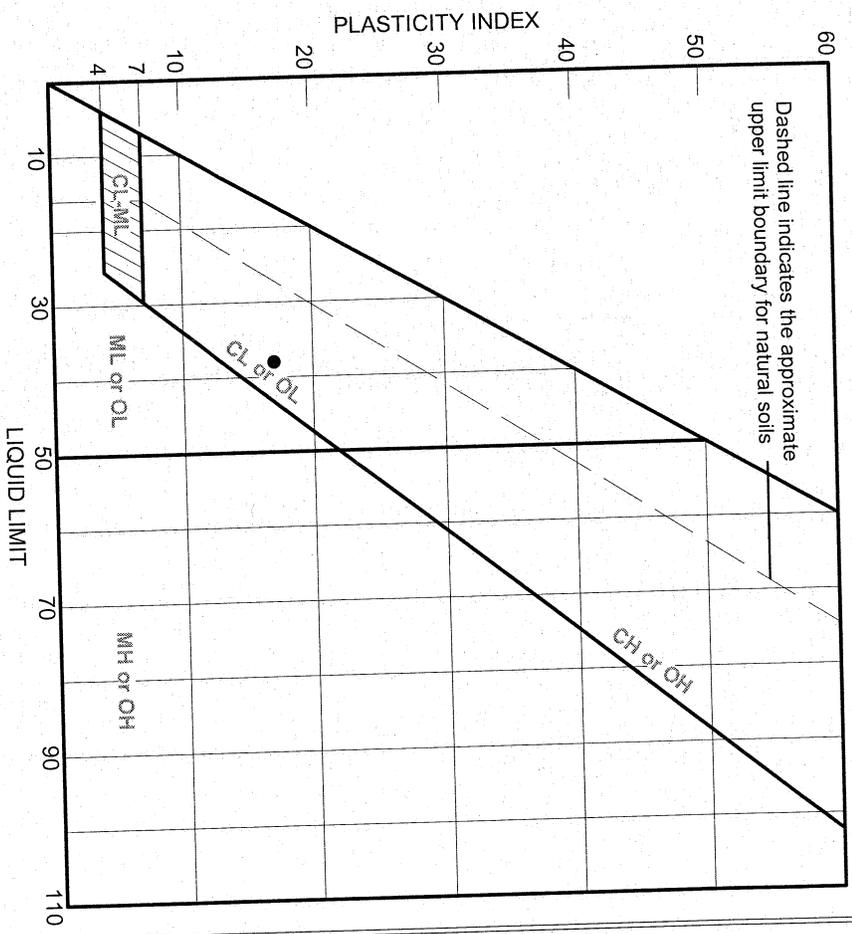
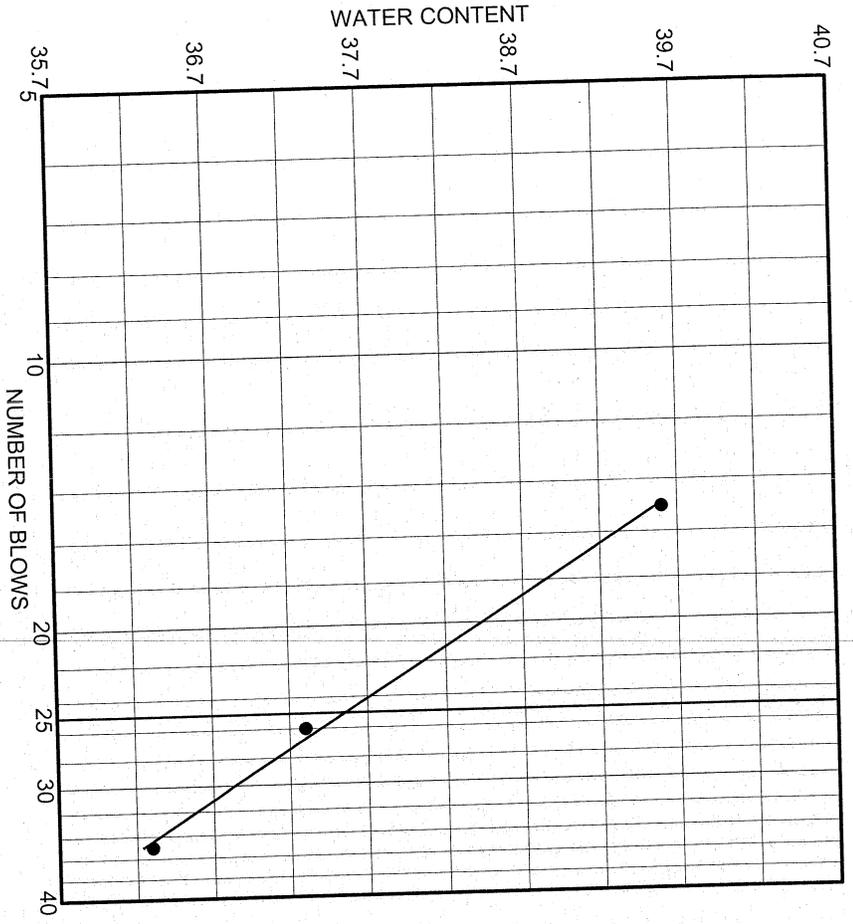
SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
	B-7	27.2-27.8 ft	12/10/09	CL	Lean clay		28	8

Client Stantec
Project Clifty Creek

Project No. GTX-1516 Lab no.

GeoTesting Express Inc.

LIQUID AND PLASTIC LIMITS TEST REPORT



SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
	B-8	25.5-25.8 ft	12/10/09	CL	Lean clay		38	17

Client Stantec
Project Clifty Creek

Project No. GTX-1516

Lab no.

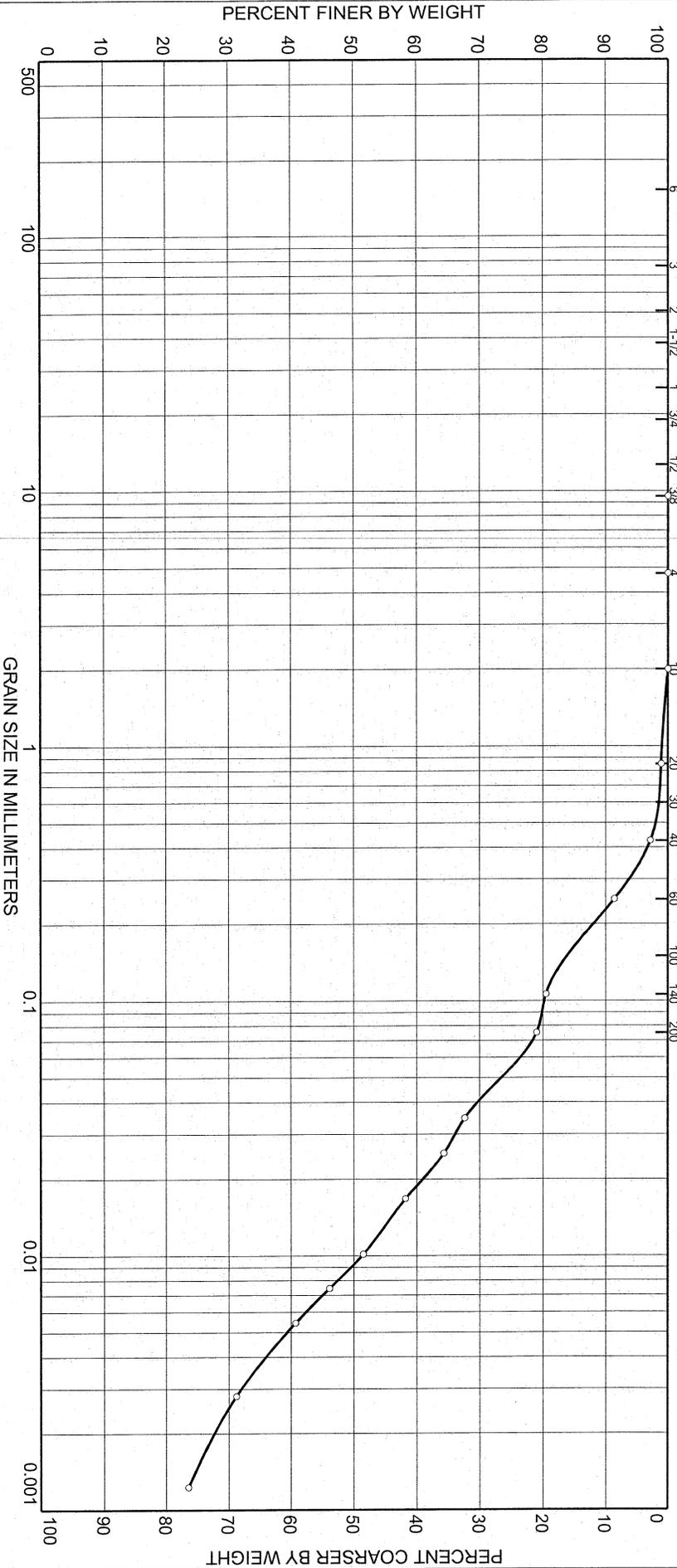
GeoTesting
Express Inc.

Particle Size Distribution Report ASTM D422

U.S. SIEVE OPENING IN INCHES

U.S. STANDARD SIEVE NUMBERS

HYDROMETER



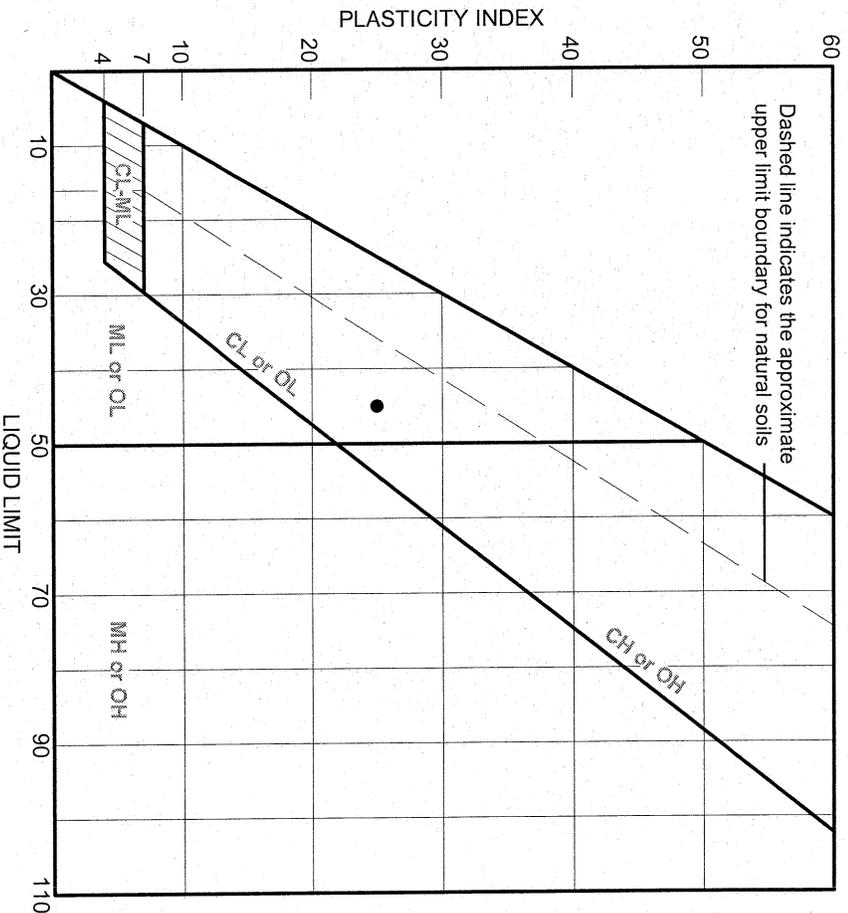
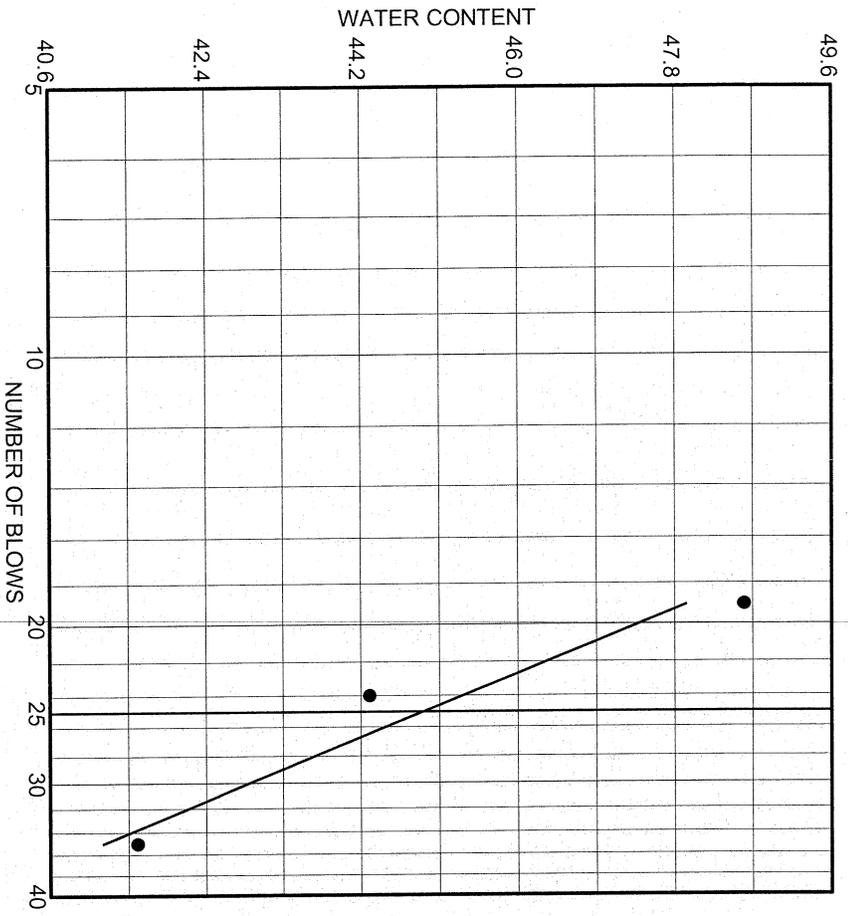
% COBBLES	0.0	% GRAVEL	0.0	% SAND	21.0	% SILT	39.6	% CLAY	39.4
-----------	-----	----------	-----	--------	------	--------	------	--------	------

SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PL
	B-8	29.7-30.3 ft	12/10/09	CL	Lean clay with sand		45	20

Client Stantec
 Project Clifty Creek

Project No. GTX-1516 Lab no. **Geo Testing Express Inc.**

LIQUID AND PLASTIC LIMITS TEST REPORT



SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
	B-8	29.7-30.3 ft	12/10/09	CL	Lean clay with sand		45	25

Client Stantec
Project Clifty Creek

Project No. GTX-1516

Lab no.

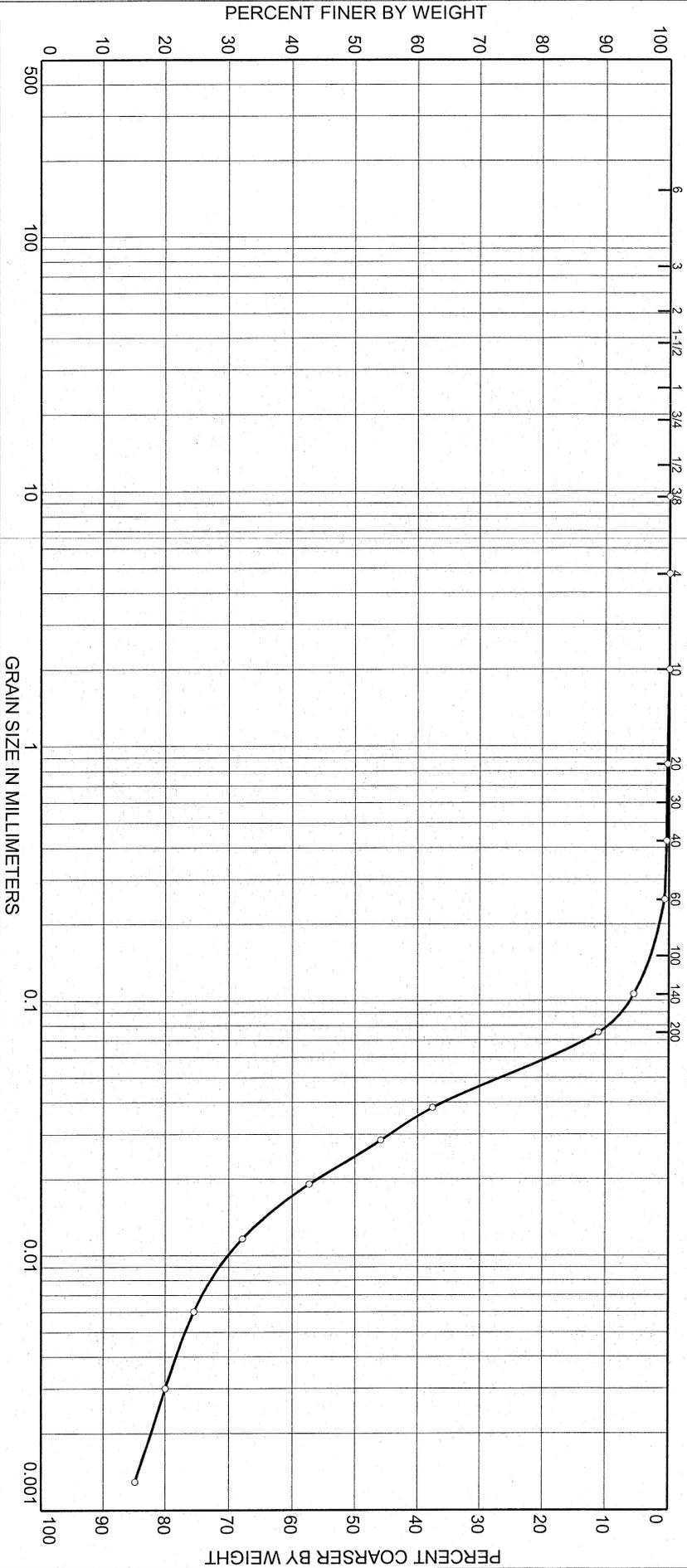
**Geo Testing
Express Inc.**

Particle Size Distribution Report ASTM D422

U.S. SIEVE OPENING IN INCHES

U.S. STANDARD SIEVE NUMBERS

HYDROMETER



% COBBLES	% GRAVEL	% SAND
0.0	0.0	11.1
% SILT	% CLAY	
65.8	23.1	

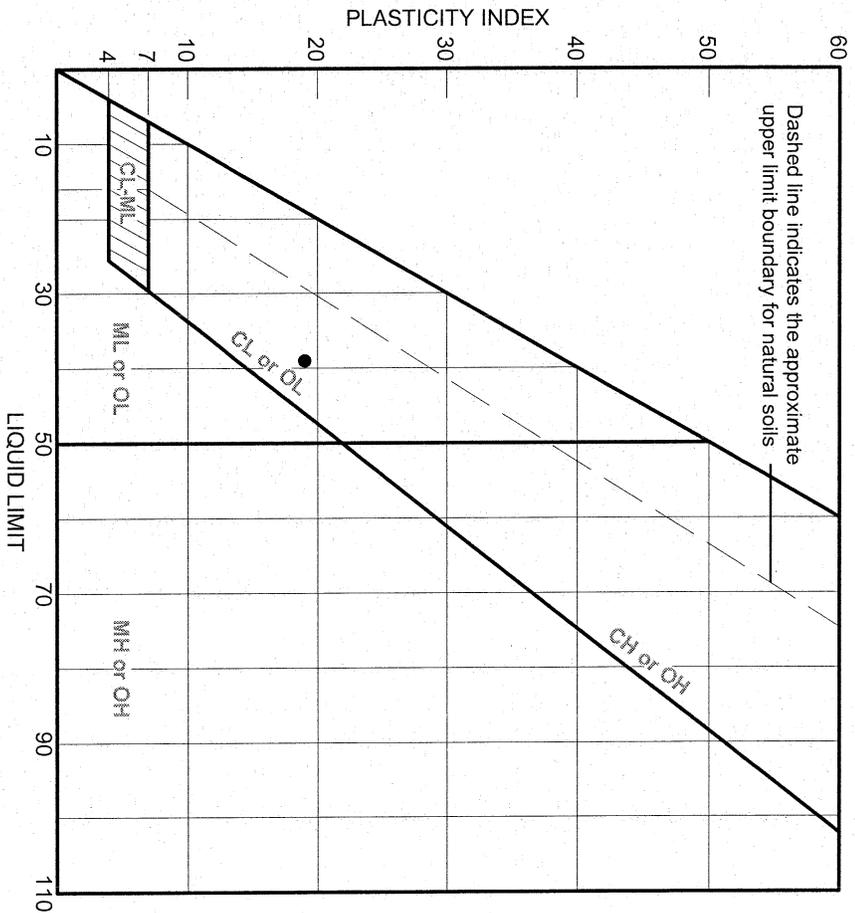
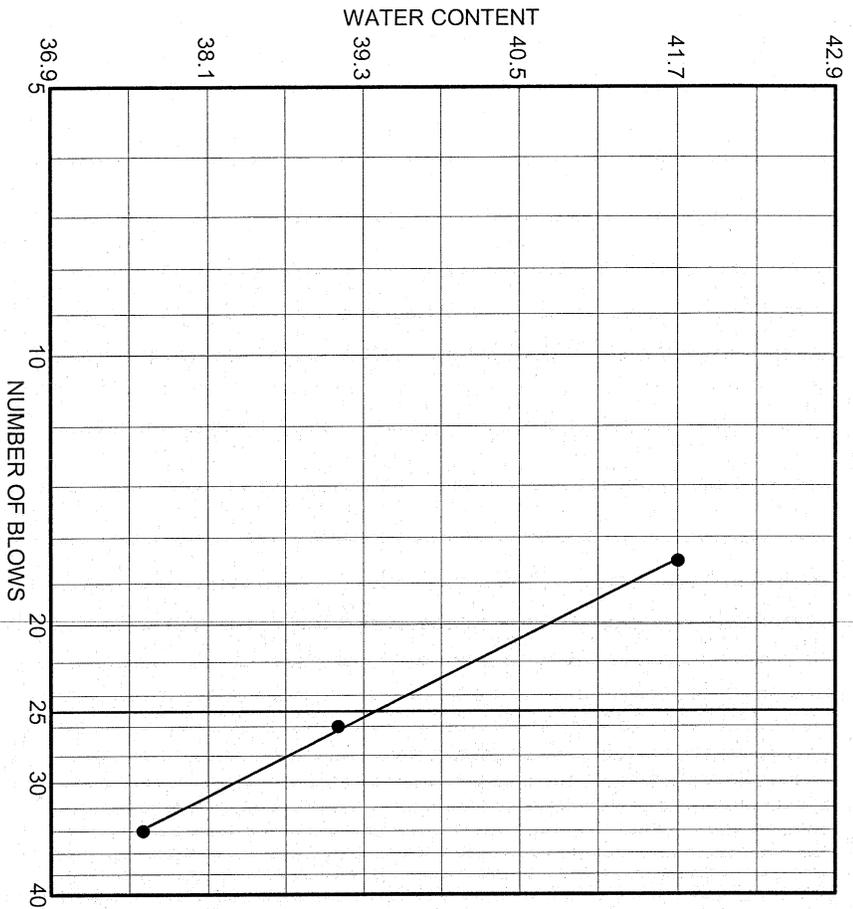
SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PL
	B-9	20.2-20.8 ft	12/10/09	CL	Lean clay		39	20

Client Stattec
Project Clifty Creek

Project No. GTX-1516 Lab no.

Geo Testing Express Inc.

LIQUID AND PLASTIC LIMITS TEST REPORT

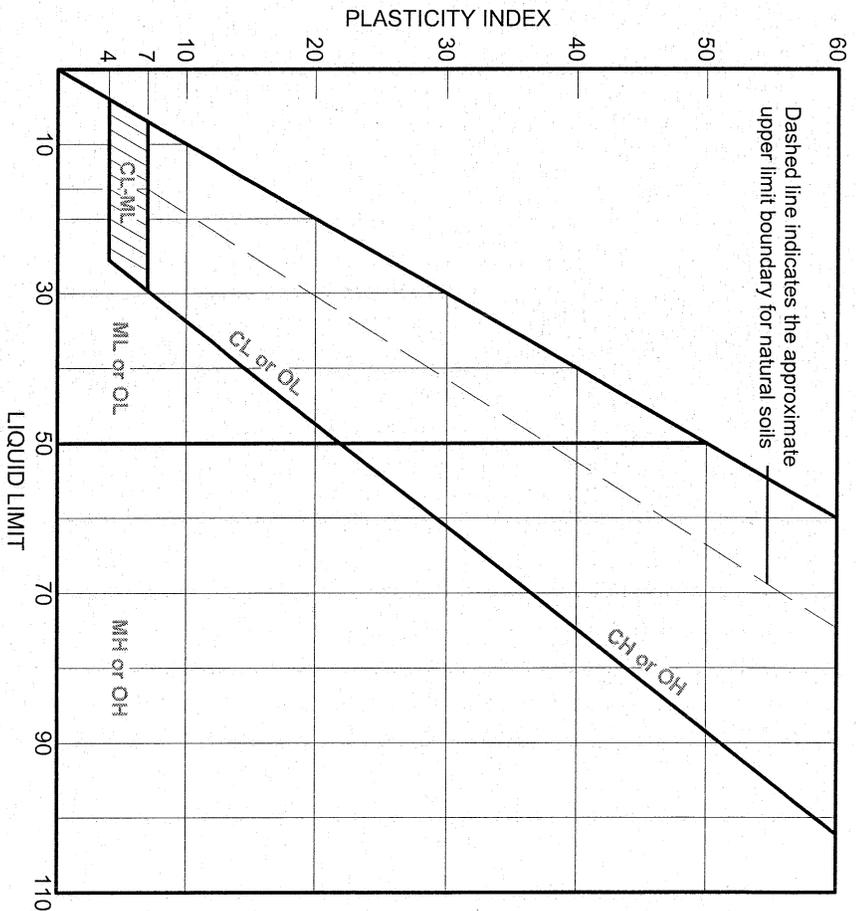


SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
	B-9	20.2-20.8 ft	12/10/09	CL	Lean clay		39	19

Client Stantec
 Project Clifty Creek
 Project No. GTX-1516 Lab no.

Geo Testing
Express Inc.

LIQUID AND PLASTIC LIMITS TEST REPORT

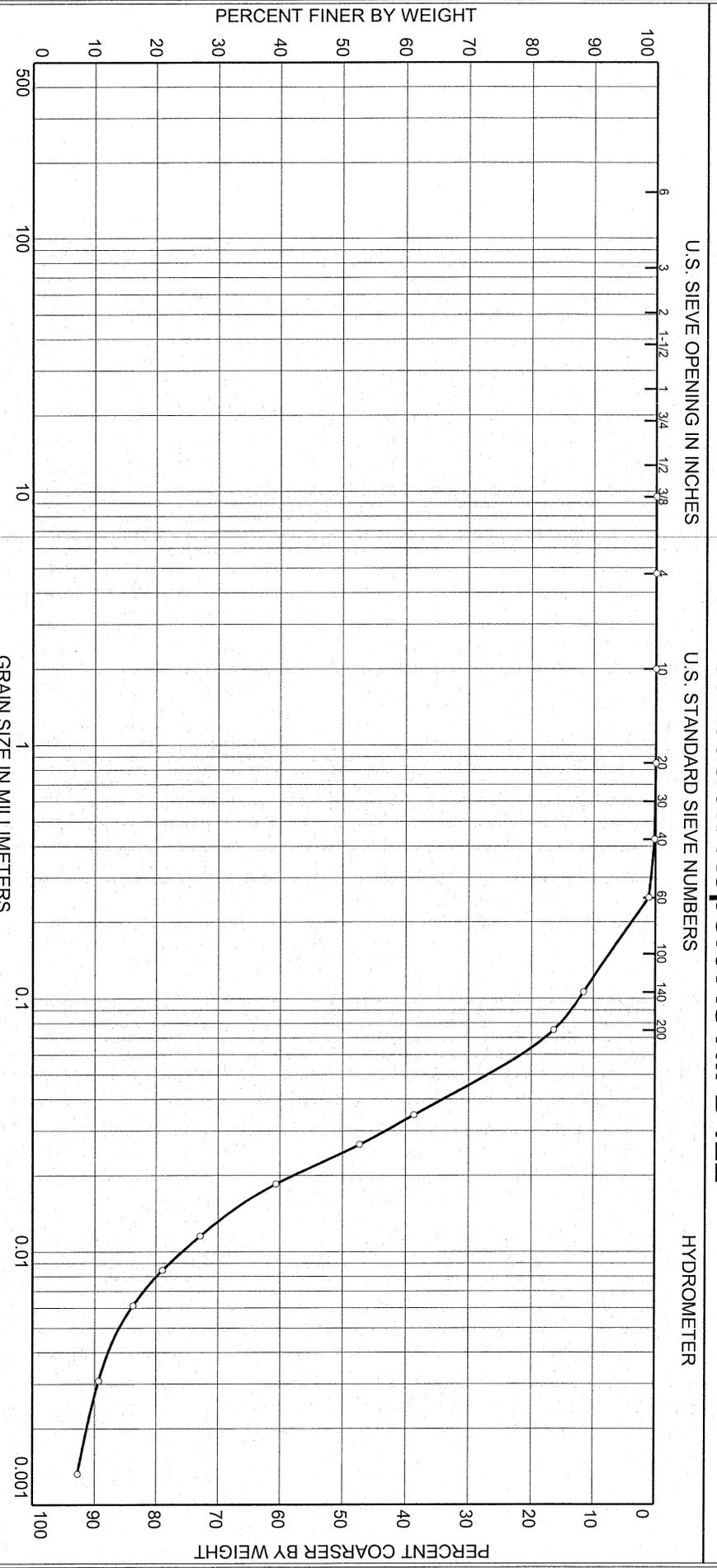


SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
	B-10	14.2-14.8 ft	12/10/09	SM	Silty sand		NV	NP

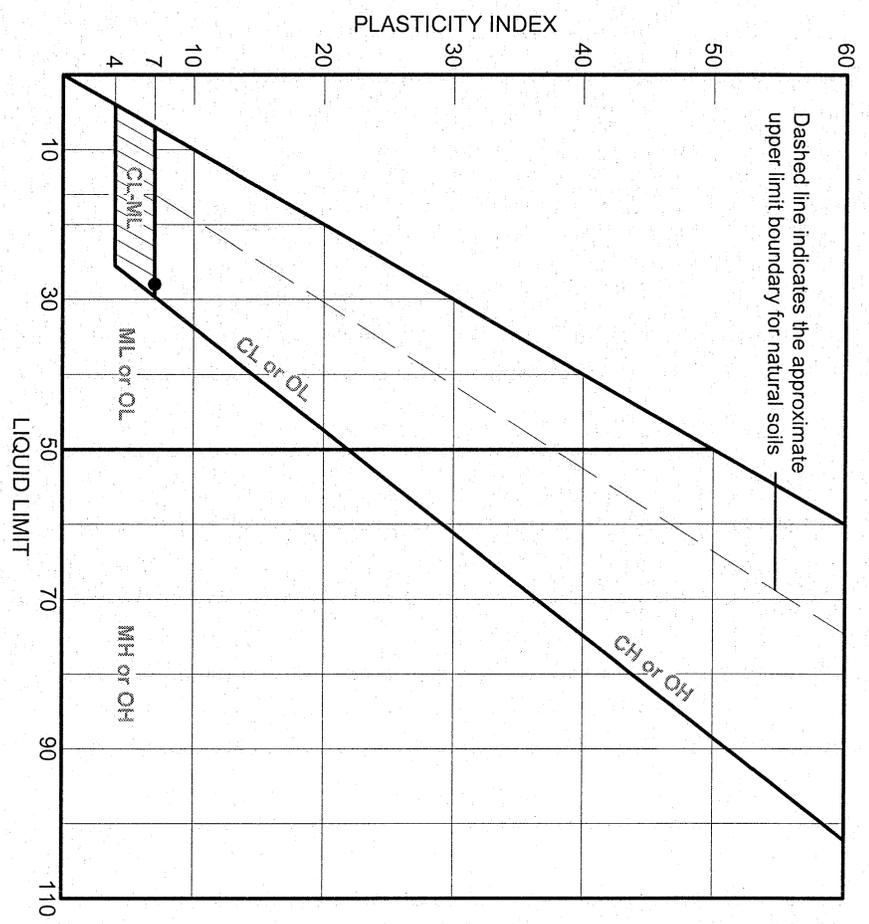
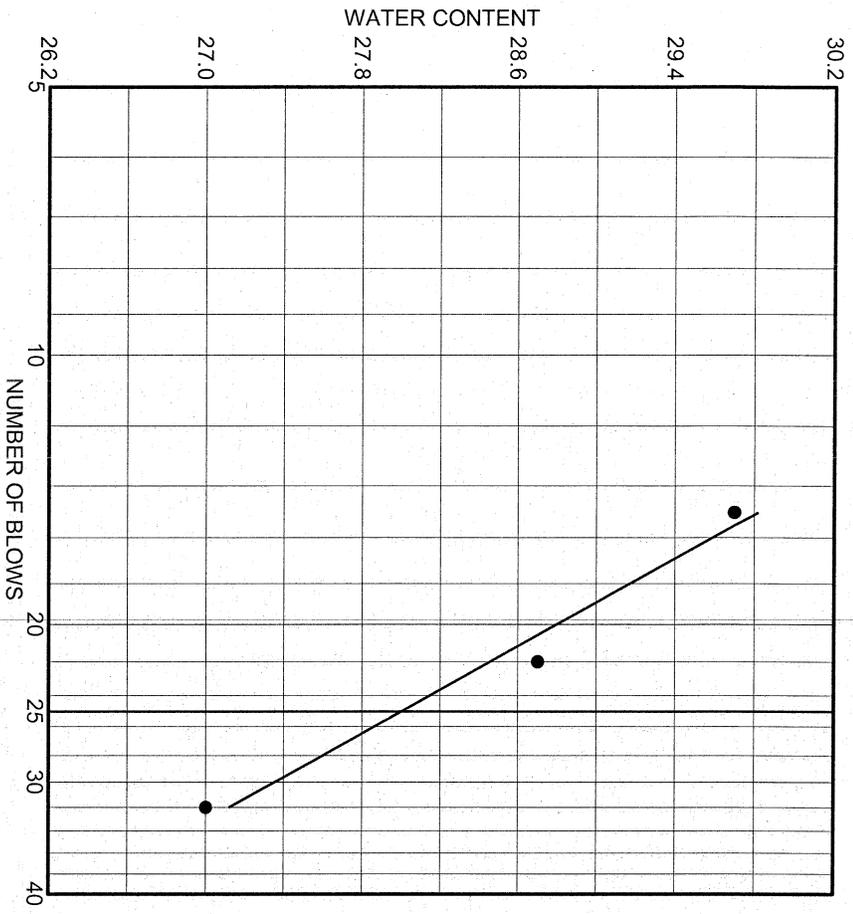
Client Stattec
 Project Clifty Creek
 Project No. GTX-1516 Lab no. _____

**Geo Testing
 Express Inc.**

Particle Size Distribution Report ASTM D422



LIQUID AND PLASTIC LIMITS TEST REPORT



SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
	B-10	16.2-16.8 ft	12/10/09	CL-ML	Silty clay with sand		28	7

Client Stattec
 Project Clifty Creek
 Project No. GTX-1516 Lab no.

**Geo Testing
 Express Inc.**

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LANDFILL RUNOFF COLLECTION POND:
2015 GEOTECHNICAL EXPLORATION



Summary of Soil Tests

Project Name CCR Rule - AEP Clifty Creek Project Number 17553022
 Source B-12, 10.0'-11.5' Lab ID 3
 Sample Type SPT Date Received 7-21-15
 Date Reported 8-3-15

Test Results

Natural Moisture Content
 Test Method: ASTM D 2216
 Moisture Content (%): 23.1

Atterberg Limits
 Test Method: ASTM D 4318 Method A
 Prepared: Dry
 Liquid Limit: 43
 Plastic Limit: 21
 Plasticity Index: 22
 Activity Index: 1.05

Particle Size Analysis
 Preparation Method: ASTM D 421
 Gradation Method: ASTM D 422
 Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	
	N/A	Passing
	N/A	
No. 4	4.75	100.0
No. 10	2	74.7
No. 40	0.425	74.1
No. 200	0.075	71.7
	0.02	54.4
	0.005	30.3
	0.002	21.1
estimated	0.001	17.0

Moisture-Density Relationship
 Test Not Performed
 Maximum Dry Density (lb/ft³): N/A
 Maximum Dry Density (kg/m³): N/A
 Optimum Moisture Content (%): N/A
 Over Size Correction %: N/A

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	25.3
Coarse Sand	25.3	0.6
Medium Sand	0.6	---
Fine Sand	2.4	2.4
Silt	41.4	50.6
Clay	30.3	21.1

California Bearing Ratio
 Test Not Performed
 Bearing Ratio (%): N/A
 Compacted Dry Density (lb/ft³): N/A
 Compacted Moisture Content (%): N/A

Specific Gravity
 Test Method: ASTM D 854
 Prepared: Dry
 Particle Size: No. 10
 Specific Gravity at 20° Celsius: 2.70

Classification
 Unified Group Symbol: CL
 Group Name: Lean clay with sand
 AASHTO Classification: A-7-6 (15)

Comments: _____

Reviewed By RJ

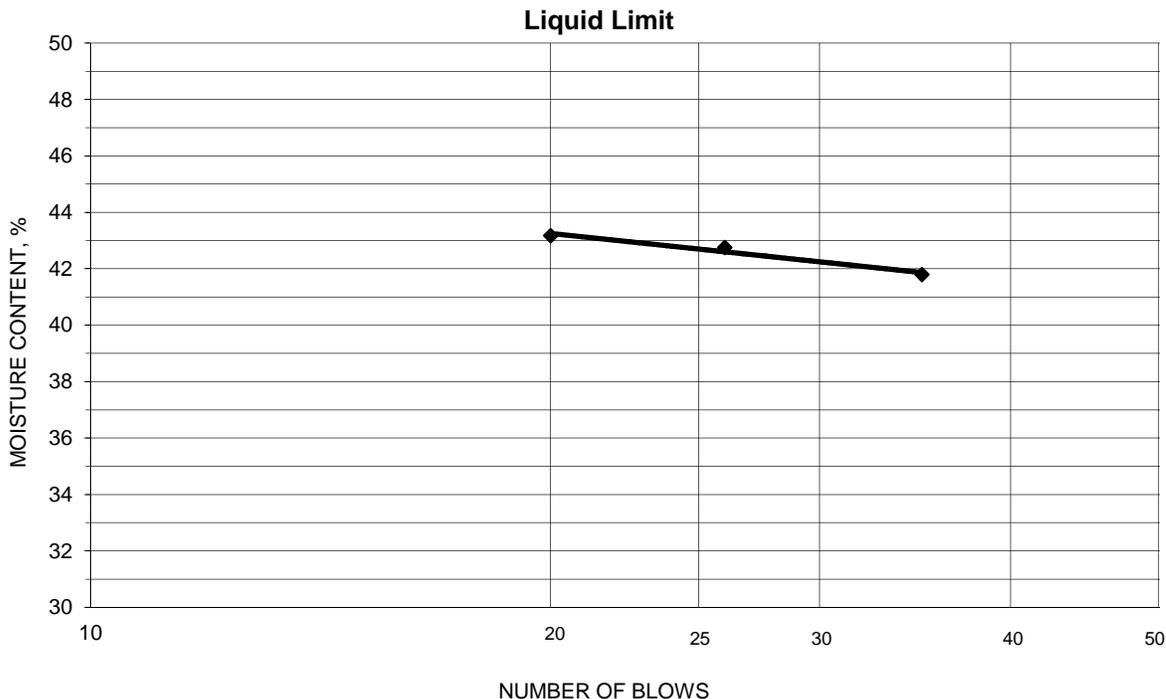


ATTERBERG LIMITS

Project CCR Rule - AEP Clifty Creek
 Source B-12, 10.0'-11.5'
 Tested By kws Test Method ASTM D 4318 Method A
 Test Date 07-27-2015 Prepared Dry

Project No. 175553022
 Lab ID 3
 % + No. 40 26
 Date Received 07-21-2015

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
19.52	17.10	11.31	35	41.8	43
18.33	16.09	10.85	26	42.7	
19.57	17.04	11.18	20	43.2	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
18.01	16.88	11.47	20.9	21	22
17.57	16.44	11.11	21.2		

Remarks: _____

Reviewed By RJ



Summary of Soil Tests

Project Name CCR Rule - AEP Clifty Creek Project Number 17553022
 Source B-12, 30.0'-31.5' Lab ID 7
 Sample Type SPT Date Received 7-21-15
 Date Reported 8-3-15

Test Results

Natural Moisture Content
 Test Method: ASTM D 2216
 Moisture Content (%): 19.0

Atterberg Limits
 Test Method: ASTM D 4318 Method A
 Prepared: Dry
 Liquid Limit: 31
 Plastic Limit: 18
 Plasticity Index: 13
 Activity Index: 0.87

Particle Size Analysis
 Preparation Method: ASTM D 421
 Gradation Method: ASTM D 422
 Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	
	N/A	Passing
	N/A	
3/4"	19	100.0
3/8"	9.5	99.8
No. 4	4.75	89.2
No. 10	2	77.8
No. 40	0.425	77.3
No. 200	0.075	71.4
	0.02	42.9
	0.005	21.6
	0.002	15.2
estimated	0.001	12.0

Moisture-Density Relationship
 Test Not Performed
 Maximum Dry Density (lb/ft³): N/A
 Maximum Dry Density (kg/m³): N/A
 Optimum Moisture Content (%): N/A
 Over Size Correction %: N/A

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	10.8	22.2
Coarse Sand	11.4	0.5
Medium Sand	0.5	---
Fine Sand	5.9	5.9
Silt	49.8	56.2
Clay	21.6	15.2

California Bearing Ratio
 Test Not Performed
 Bearing Ratio (%): N/A
 Compacted Dry Density (lb/ft³): N/A
 Compacted Moisture Content (%): N/A

Specific Gravity
 Test Method: ASTM D 854
 Prepared: Dry
 Particle Size: No. 10
 Specific Gravity at 20° Celsius: 2.68

Classification
 Unified Group Symbol: CL
 Group Name: Lean clay with sand
 AASHTO Classification: A-6 (7)

Comments: _____

Reviewed By RJ

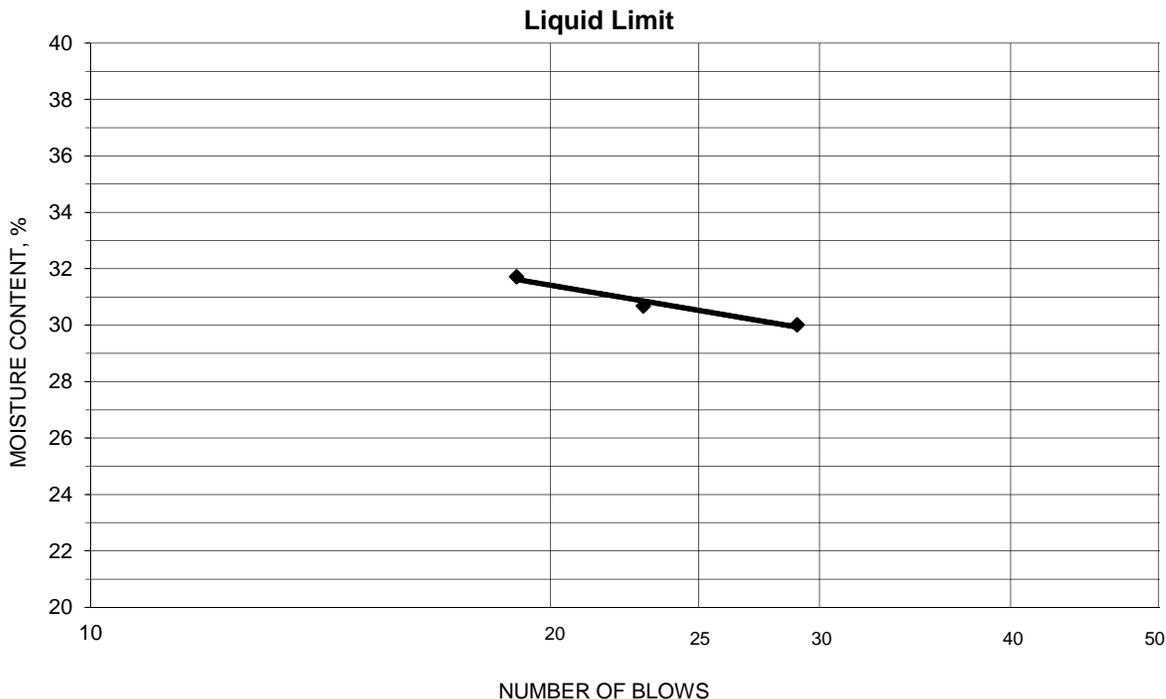


ATTERBERG LIMITS

Project CCR Rule - AEP Clifty Creek
 Source B-12, 30.0'-31.5'
 Tested By KG Test Method ASTM D 4318 Method A
 Test Date 07-31-2015 Prepared Dry

Project No. 175553022
 Lab ID 7
 % + No. 40 23
 Date Received 07-21-2015

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
19.80	17.75	10.92	29	30.0	31
19.72	17.68	11.03	23	30.7	
20.84	18.48	11.04	19	31.7	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
19.95	18.61	11.11	17.9	18	13
20.10	18.75	11.18	17.8		

Remarks: _____

Reviewed By RJ



Summary of Soil Tests

Project Name CCR Rule - AEP Clifty Creek Project Number 17553022
 Source B-12, 45.0'-46.5' Lab ID 10
 Sample Type SPT Date Received 7-21-15
 Date Reported 8-3-15

Test Results

Natural Moisture Content
 Test Method: ASTM D 2216
 Moisture Content (%): 18.7

Atterberg Limits
 Test Method: ASTM D 4318 Method A
 Prepared: Dry
 Liquid Limit: 26
 Plastic Limit: 19
 Plasticity Index: 7
 Activity Index: 0.64

Particle Size Analysis
 Preparation Method: ASTM D 421
 Gradation Method: ASTM D 422
 Hydrometer Method: ASTM D 422

Particle Size		% Passing
Sieve Size	(mm)	
	N/A	
No. 4	4.75	100.0
No. 10	2	99.3
No. 40	0.425	99.2
No. 200	0.075	82.2
	0.02	34.0
	0.005	14.0
	0.002	10.7
estimated	0.001	10.0

Moisture-Density Relationship
 Test Not Performed
 Maximum Dry Density (lb/ft³): N/A
 Maximum Dry Density (kg/m³): N/A
 Optimum Moisture Content (%): N/A
 Over Size Correction %: N/A

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	0.7
Coarse Sand	0.7	0.1
Medium Sand	0.1	---
Fine Sand	17.0	17.0
Silt	68.2	71.5
Clay	14.0	10.7

California Bearing Ratio
 Test Not Performed
 Bearing Ratio (%): N/A
 Compacted Dry Density (lb/ft³): N/A
 Compacted Moisture Content (%): N/A

Specific Gravity
 Test Method: ASTM D 854
 Prepared: Dry
 Particle Size: No. 10
 Specific Gravity at 20° Celsius: 2.72

Classification
 Unified Group Symbol: CL-ML
 Group Name: Silty clay with sand
 AASHTO Classification: A-4 (4)

Comments: _____

Reviewed By RJ

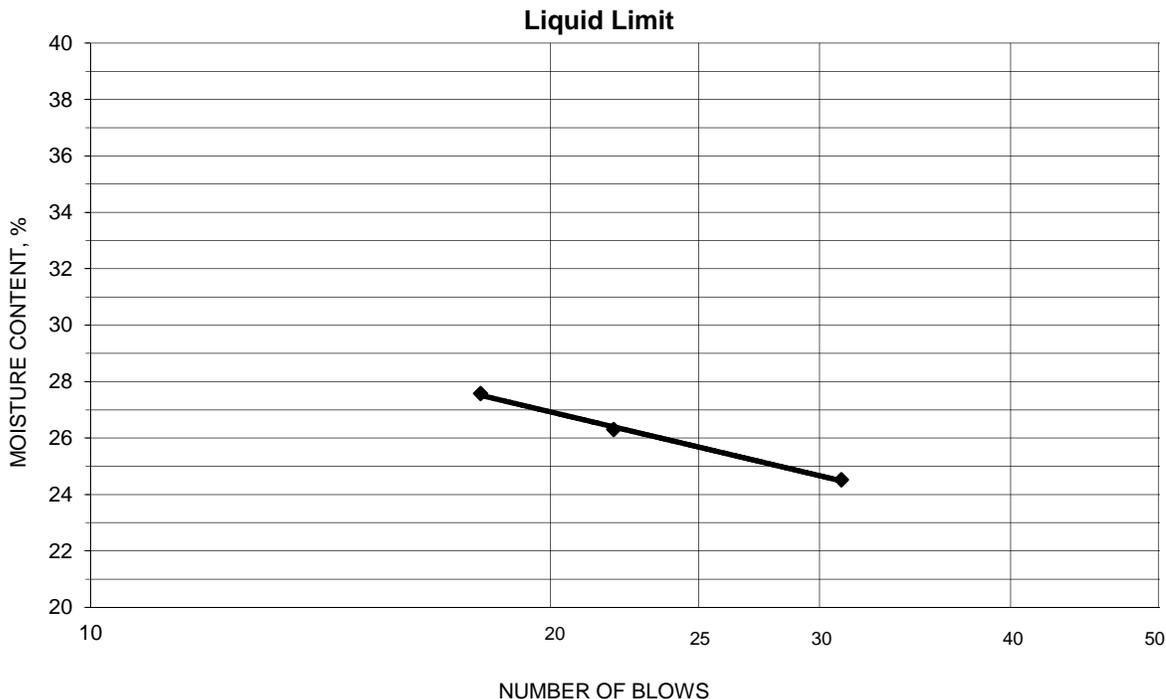


ATTERBERG LIMITS

Project CCR Rule - AEP Clifty Creek
 Source B-12, 45.0'-46.5'
 Tested By TA Test Method ASTM D 4318 Method A
 Test Date 07-30-2015 Prepared Dry

Project No. 175553022
 Lab ID 10
 % + No. 40 1
 Date Received 07-21-2015

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
19.13	17.46	11.11	22	26.3	26
21.65	19.32	10.87	18	27.6	
22.47	20.32	11.55	31	24.5	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
17.45	16.47	11.42	19.4	19	7
17.70	16.74	11.60	18.7		

Remarks: _____

Reviewed By RJ



Summary of Soil Tests

Project Name CCR Rule - AEP Clifty Creek Project Number 17553022
 Source B-12, 50.0'-51.5' Lab ID 11
 Sample Type SPT Date Received 7-21-15
 Date Reported 8-3-15

Test Results

Natural Moisture Content
 Test Method: ASTM D 2216
 Moisture Content (%): 21.9

Atterberg Limits
 Test Method: ASTM D 4318 Method A
 Prepared: Dry
 Liquid Limit: NP
 Plastic Limit: NP
 Plasticity Index: NP
 Activity Index: N/A

Particle Size Analysis
 Preparation Method: ASTM D 421
 Gradation Method: ASTM D 422
 Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	
	N/A	Passing
	N/A	
No. 10	2	100.0
No. 40	0.425	99.8
No. 200	0.075	81.3
	0.02	29.1
	0.005	6.3
	0.002	3.2
estimated	0.001	1.0

Moisture-Density Relationship
 Test Not Performed
 Maximum Dry Density (lb/ft³): N/A
 Maximum Dry Density (kg/m³): N/A
 Optimum Moisture Content (%): N/A
 Over Size Correction %: N/A

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	0.0
Coarse Sand	0.0	0.2
Medium Sand	0.2	---
Fine Sand	18.5	18.5
Silt	75.0	78.1
Clay	6.3	3.2

California Bearing Ratio
 Test Not Performed
 Bearing Ratio (%): N/A
 Compacted Dry Density (lb/ft³): N/A
 Compacted Moisture Content (%): N/A

Specific Gravity
 Test Method: ASTM D 854
 Prepared: Dry
 Particle Size: No. 10
 Specific Gravity at 20° Celsius: 2.68

Classification
 Unified Group Symbol: ML
 Group Name: Silt with sand
 AASHTO Classification: A-4 (0)

Comments: _____

Reviewed By RJ

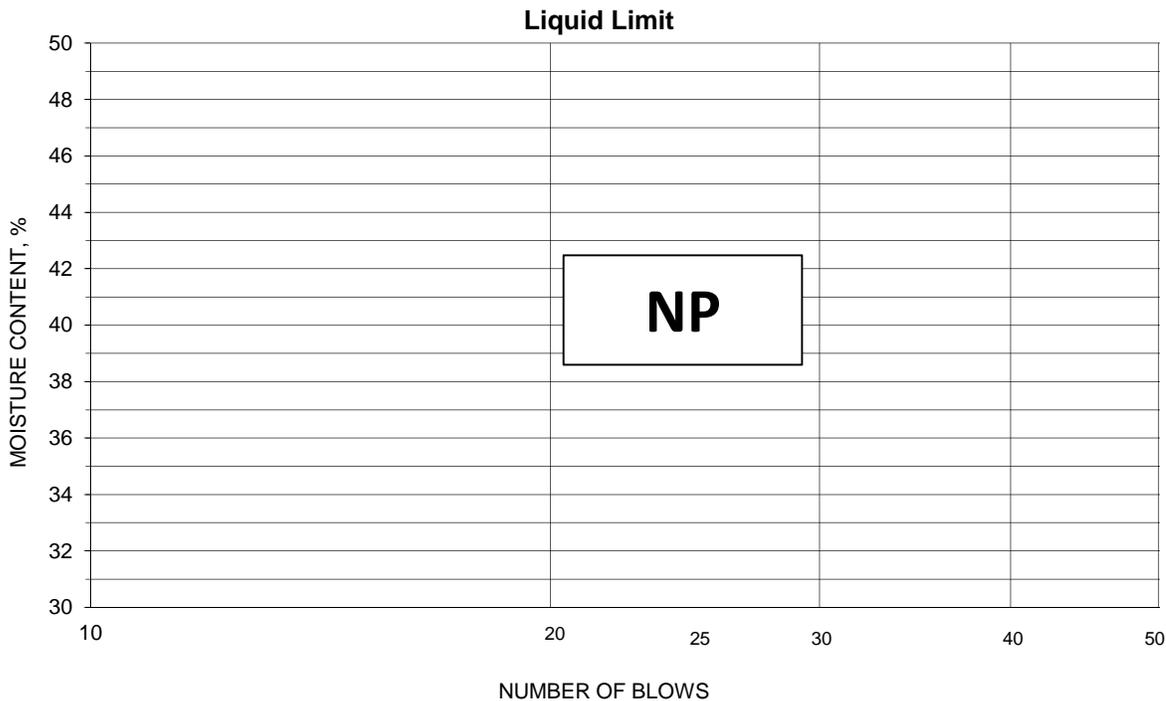


ATTERBERG LIMITS

Project CCR Rule - AEP Clifty Creek
 Source B-12, 50.0'-51.5'
 Tested By TA Test Method ASTM D 4318 Method A
 Test Date 07-30-2015 Prepared Dry

Project No. 175553022
 Lab ID 11
 % + No. 40 0
 Date Received 07-21-2015

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index

Remarks: _____

Reviewed By RJ



Summary of Soil Tests

Project Name CCR Rule - AEP Clifty Creek Project Number 17553022
 Source B-12, 60.0'-61.5' Lab ID 13
 Sample Type SPT Date Received 7-21-15
 Date Reported 8-3-15

Test Results

Natural Moisture Content
 Test Method: ASTM D 2216
 Moisture Content (%): 14.8

Atterberg Limits
 Test Method: ASTM D 4318 Method A
 Prepared: Dry
 Liquid Limit: NP
 Plastic Limit: NP
 Plasticity Index: NP
 Activity Index: N/A

Particle Size Analysis
 Preparation Method: ASTM D 421
 Gradation Method: ASTM D 422
 Hydrometer Method: ASTM D 422

Particle Size		% Passing
Sieve Size	(mm)	
	N/A	
No. 4	4.75	100.0
No. 10	2	98.5
No. 40	0.425	95.7
No. 200	0.075	36.1
	0.02	12.4
	0.005	5.1
	0.002	2.8
estimated	0.001	1.0

Moisture-Density Relationship
 Test Not Performed
 Maximum Dry Density (lb/ft³): N/A
 Maximum Dry Density (kg/m³): N/A
 Optimum Moisture Content (%): N/A
 Over Size Correction %: N/A

Plus 3 in. material, not included: 0 (%)

California Bearing Ratio
 Test Not Performed
 Bearing Ratio (%): N/A
 Compacted Dry Density (lb/ft³): N/A
 Compacted Moisture Content (%): N/A

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	1.5
Coarse Sand	1.5	2.8
Medium Sand	2.8	---
Fine Sand	59.6	59.6
Silt	31.0	33.3
Clay	5.1	2.8

Specific Gravity
 Test Method: ASTM D 854
 Prepared: Dry
 Particle Size: No. 10
 Specific Gravity at 20° Celsius: 2.75

Classification
 Unified Group Symbol: SM
 Group Name: Silty sand
 AASHTO Classification: A-4 (0)

Comments: _____

Reviewed By RJ

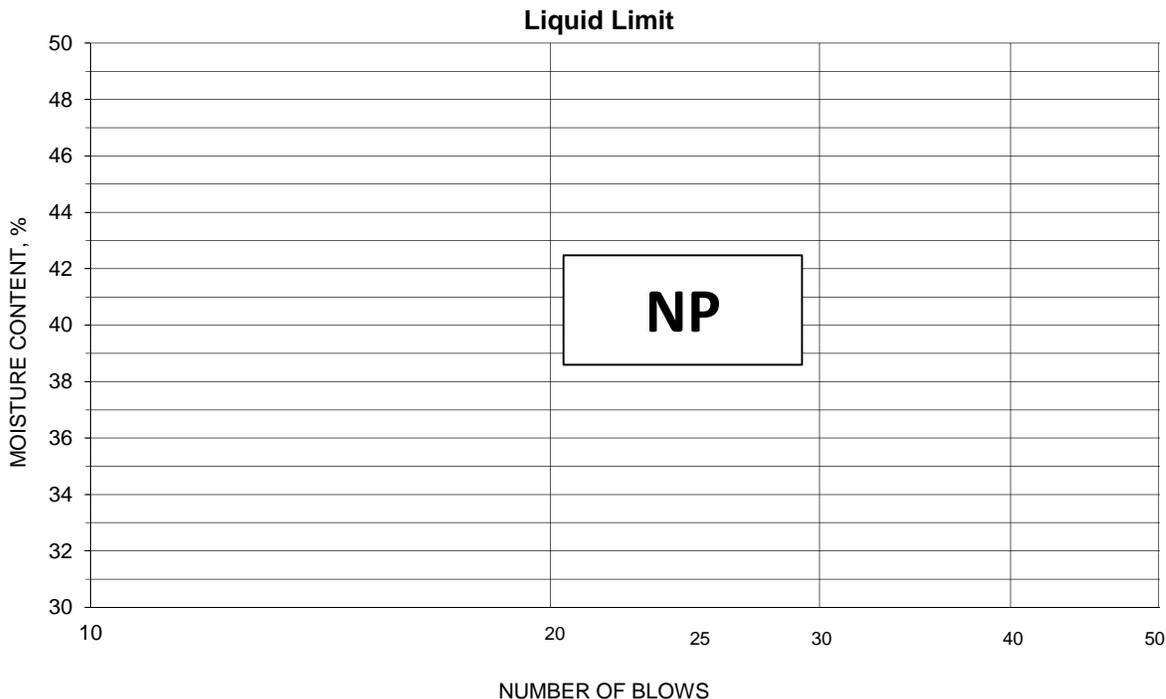


ATTERBERG LIMITS

Project CCR Rule - AEP Clifty Creek
 Source B-12, 60.0'-61.5'
 Tested By DB Test Method ASTM D 4318 Method A
 Test Date 07-24-2015 Prepared Dry

Project No. 175553022
 Lab ID 13
 % + No. 40 4
 Date Received 07-21-2015

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index

Remarks: _____

Reviewed By RJ



Summary of Soil Tests

Project Name CCR Rule - AEP Clifty Creek Project Number 17553022
 Source B-12, 70.0'-71.5' Lab ID 15
 Sample Type SPT Date Received 7-21-15
 Date Reported 8-3-15

Test Results

Natural Moisture Content
 Test Method: ASTM D 2216
 Moisture Content (%): 21.6

Atterberg Limits
 Test Method: ASTM D 4318 Method A
 Prepared: Dry
 Liquid Limit: NP
 Plastic Limit: NP
 Plasticity Index: NP
 Activity Index: N/A

Particle Size Analysis
 Preparation Method: ASTM D 421
 Gradation Method: ASTM D 422
 Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	
	N/A	Passing
	N/A	
No. 10	2	100.0
No. 40	0.425	98.6
No. 200	0.075	56.5
	0.02	21.7
	0.005	3.7
	0.002	1.5
estimated	0.001	1.0

Moisture-Density Relationship
 Test Not Performed
 Maximum Dry Density (lb/ft³): N/A
 Maximum Dry Density (kg/m³): N/A
 Optimum Moisture Content (%): N/A
 Over Size Correction %: N/A

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	0.0
Coarse Sand	0.0	1.4
Medium Sand	1.4	---
Fine Sand	42.1	42.1
Silt	52.8	55.0
Clay	3.7	1.5

California Bearing Ratio
 Test Not Performed
 Bearing Ratio (%): N/A
 Compacted Dry Density (lb/ft³): N/A
 Compacted Moisture Content (%): N/A

Specific Gravity
 Test Method: ASTM D 854
 Prepared: Dry
 Particle Size: No. 10
 Specific Gravity at 20° Celsius: 2.71

Classification
 Unified Group Symbol: ML
 Group Name: Sandy silt
 AASHTO Classification: A-4 (0)

Comments: _____

Reviewed By RJ

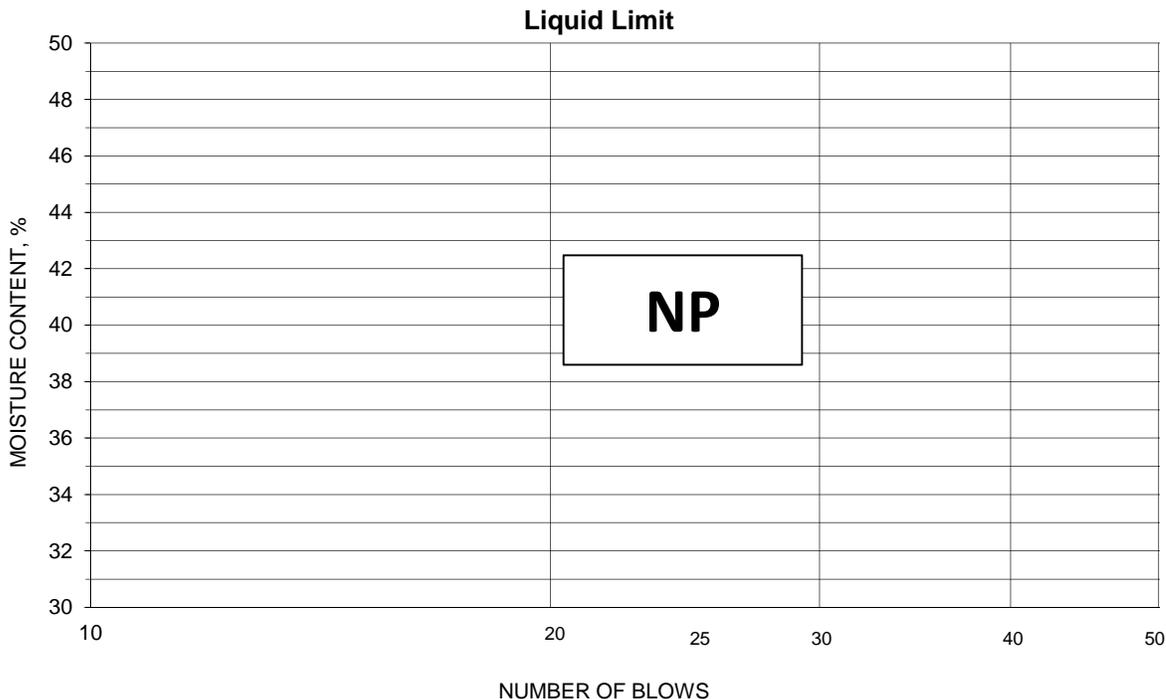


ATTERBERG LIMITS

Project CCR Rule - AEP Clifty Creek
 Source B-12, 70.0'-71.5'
 Tested By KDG Test Method ASTM D 4318 Method A
 Test Date 07-31-2015 Prepared Dry

Project No. 175553022
 Lab ID 15
 % + No. 40 1
 Date Received 07-21-2015

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index

Remarks: _____

Reviewed By RJ



Summary of Soil Tests

Project Name CCR Rule - AEP Clifty Creek Project Number 17553022
 Source B-12, 80.0'-81.5' Lab ID 17
 Sample Type SPT Date Received 7-21-15
 Date Reported 8-3-15

Test Results

Natural Moisture Content
 Test Method: ASTM D 2216
 Moisture Content (%): 25.7

Atterberg Limits
 Test Method: ASTM D 4318 Method A
 Prepared: Dry
 Liquid Limit: NP
 Plastic Limit: NP
 Plasticity Index: NP
 Activity Index: N/A

Particle Size Analysis
 Preparation Method: ASTM D 421
 Gradation Method: ASTM D 422
 Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	
	N/A	Passing
	N/A	
No. 4	4.75	100.0
No. 10	2	98.9
No. 40	0.425	98.9
No. 200	0.075	90.2
	0.02	28.8
	0.005	5.6
	0.002	1.4
estimated	0.001	0.0

Moisture-Density Relationship
 Test Not Performed
 Maximum Dry Density (lb/ft³): N/A
 Maximum Dry Density (kg/m³): N/A
 Optimum Moisture Content (%): N/A
 Over Size Correction %: N/A

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	1.1
Coarse Sand	1.1	0.0
Medium Sand	0.0	---
Fine Sand	8.7	8.7
Silt	84.6	88.8
Clay	5.6	1.4

California Bearing Ratio
 Test Not Performed
 Bearing Ratio (%): N/A
 Compacted Dry Density (lb/ft³): N/A
 Compacted Moisture Content (%): N/A

Specific Gravity
 Test Method: ASTM D 854
 Prepared: Dry
 Particle Size: No. 10
 Specific Gravity at 20° Celsius: 2.73

Classification
 Unified Group Symbol: ML
 Group Name: Silt
 AASHTO Classification: A-4 (0)

Comments: _____

Reviewed By RJ

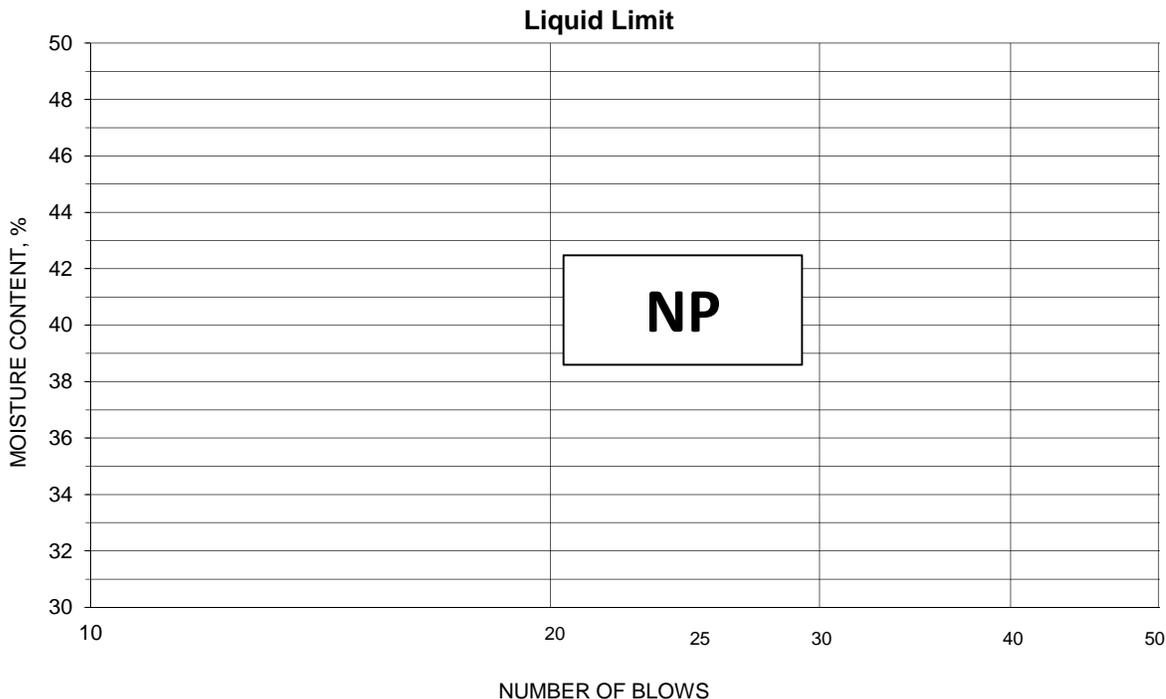


ATTERBERG LIMITS

Project CCR Rule - AEP Clifty Creek
 Source B-12, 80.0'-81.5'
 Tested By KG Test Method ASTM D 4318 Method A
 Test Date 07-24-2015 Prepared Dry

Project No. 175553022
 Lab ID 17
 % + No. 40 1
 Date Received 07-21-2015

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index

Remarks: _____

Reviewed By RJ



Summary of Soil Tests

Project Name CCR Rule - AEP Clifty Creek Project Number 17553022
 Source B-12, 95.0'-96.5' Lab ID 20
 Sample Type SPT Date Received 7-21-15
 Date Reported 8-3-15

Test Results

Natural Moisture Content

Test Method: ASTM D 2216
 Moisture Content (%): 23.4

Atterberg Limits

Test Method: ASTM D 4318 Method A
 Prepared: Dry
 Liquid Limit: 42
 Plastic Limit: 19
 Plasticity Index: 23
 Activity Index: 0.74

Particle Size Analysis

Preparation Method: ASTM D 421
 Gradation Method: ASTM D 422
 Hydrometer Method: ASTM D 422

Particle Size		%
Sieve Size	(mm)	
	N/A	Passing
	N/A	
No. 4	4.75	100.0
No. 10	2	92.9
No. 40	0.425	92.4
No. 200	0.075	86.2
	0.02	71.6
	0.005	43.0
	0.002	30.6
estimated	0.001	26.0

Plus 3 in. material, not included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	0.0	7.1
Coarse Sand	7.1	0.5
Medium Sand	0.5	---
Fine Sand	6.2	6.2
Silt	43.2	55.6
Clay	43.0	30.6

Moisture-Density Relationship

Test Not Performed
 Maximum Dry Density (lb/ft³): N/A
 Maximum Dry Density (kg/m³): N/A
 Optimum Moisture Content (%): N/A
 Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed
 Bearing Ratio (%): N/A
 Compacted Dry Density (lb/ft³): N/A
 Compacted Moisture Content (%): N/A

Specific Gravity

Test Method: ASTM D 854
 Prepared: Dry
 Particle Size: No. 10
 Specific Gravity at 20° Celsius: 2.68

Classification

Unified Group Symbol: CL
 Group Name: Lean clay
 AASHTO Classification: A-7-6 (20)

Comments: _____

Reviewed By RJ

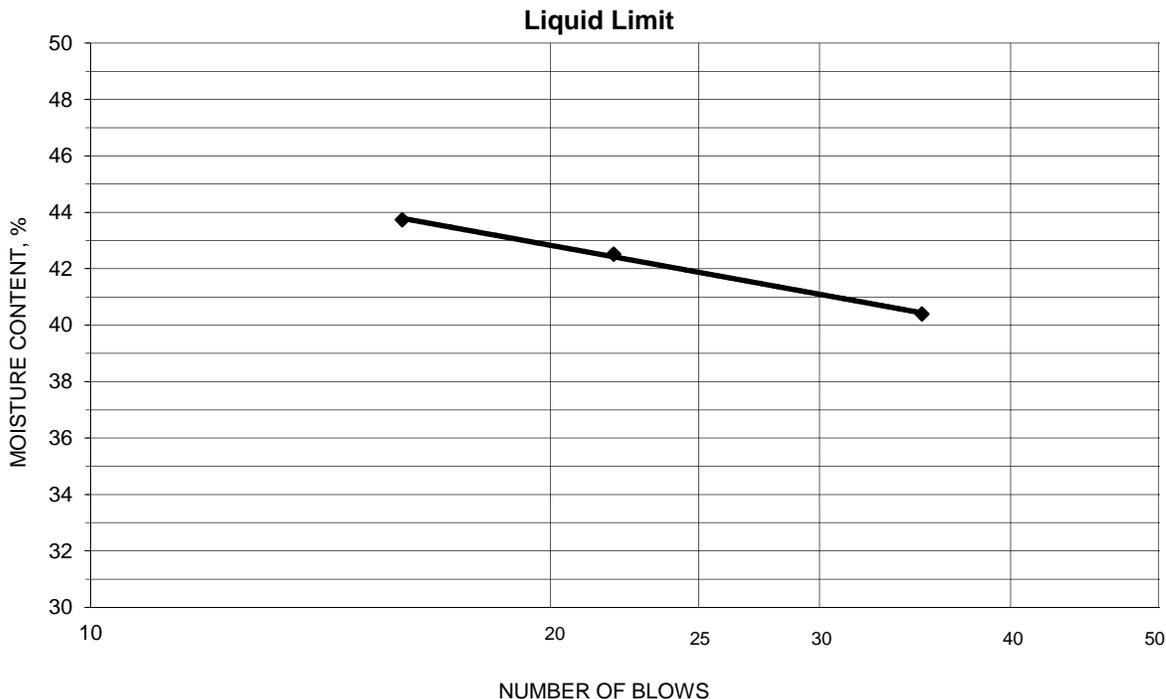


ATTERBERG LIMITS

Project CCR Rule - AEP Clifty Creek
 Source B-12, 95.0'-96.5'
 Tested By KDG Test Method ASTM D 4318 Method A
 Test Date 07-31-2015 Prepared Dry

Project No. 175553022
 Lab ID 20
 % + No. 40 8
 Date Received 07-21-2015

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
23.24	19.63	11.14	22	42.5	42
20.15	17.36	10.98	16	43.7	
21.03	18.17	11.09	35	40.4	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
17.59	16.51	10.80	18.9	19	23
17.15	16.14	10.89	19.2		

Remarks: _____

Reviewed By RJ

APPENDIX E

CONSOLIDATED-UNDRAINED TRIAXIAL TESTS

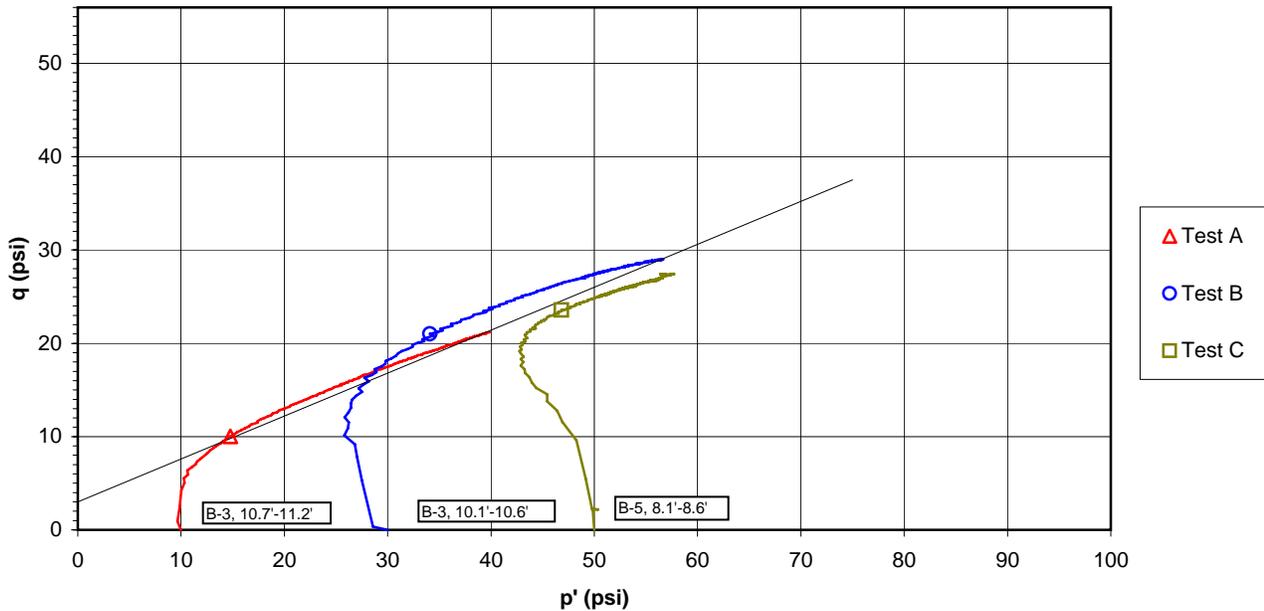
BOILER SLAG POND DAM

Project AEP-Clifty Creek-West Bottom and Fly Ash Ponds subsurface exploration
 Sample ID B-3, 10.7'-11.2' & B-3, 10.1'-10.6' & B-5, 8.1'-8.6'

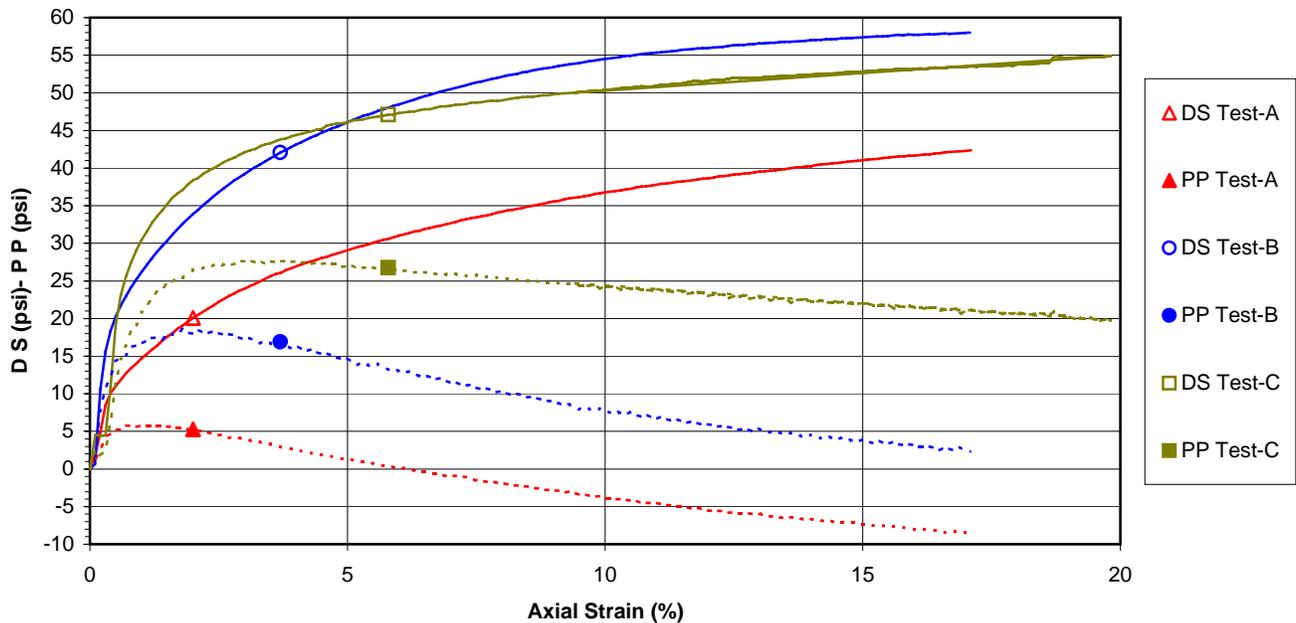
Project No. 175539022
 Test Number 1

Failure Criterion: $\phi' = 27.4 \text{ deg.}$ $c' = 490 \text{ psf}$
 Maximum Effective Principal Stress Ratio

p' vs. q Plot



Deviator Stress and Induced Pore Pressure vs. Axial Strain

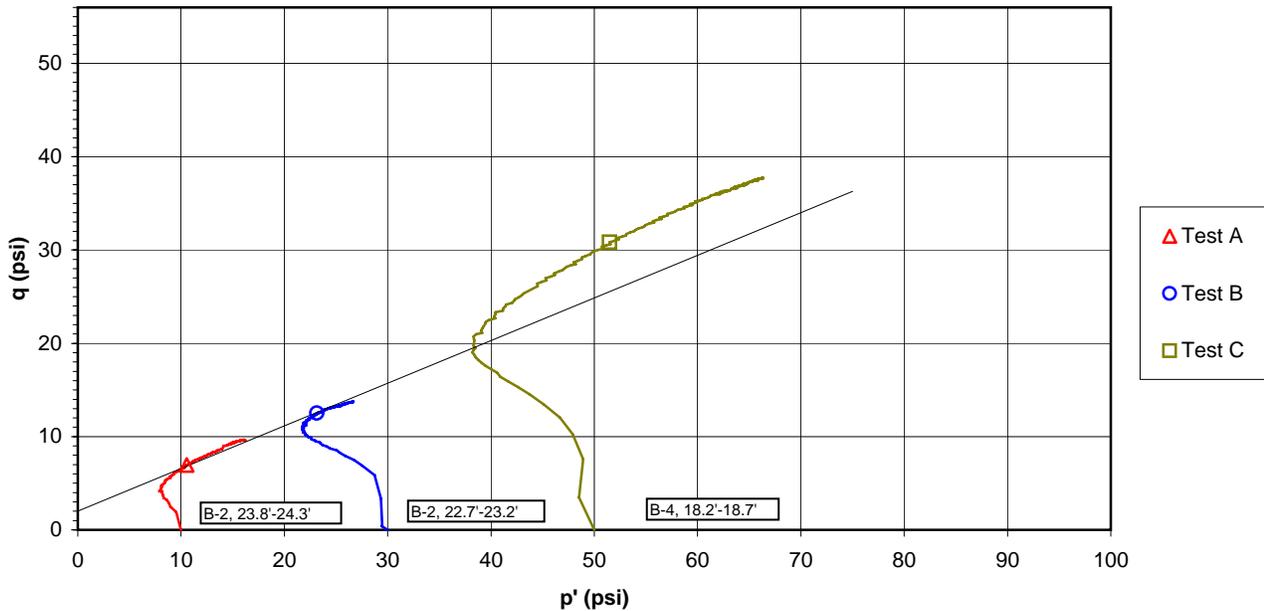


Project AEP-Clifty Creek-West Bottom Ash and Fly Ash Ponds subsurface exploration
 Sample ID B-2, 23.8'-24.3' & B-2, 22.7'-23.2' & B-4, 18.2'-18.7'

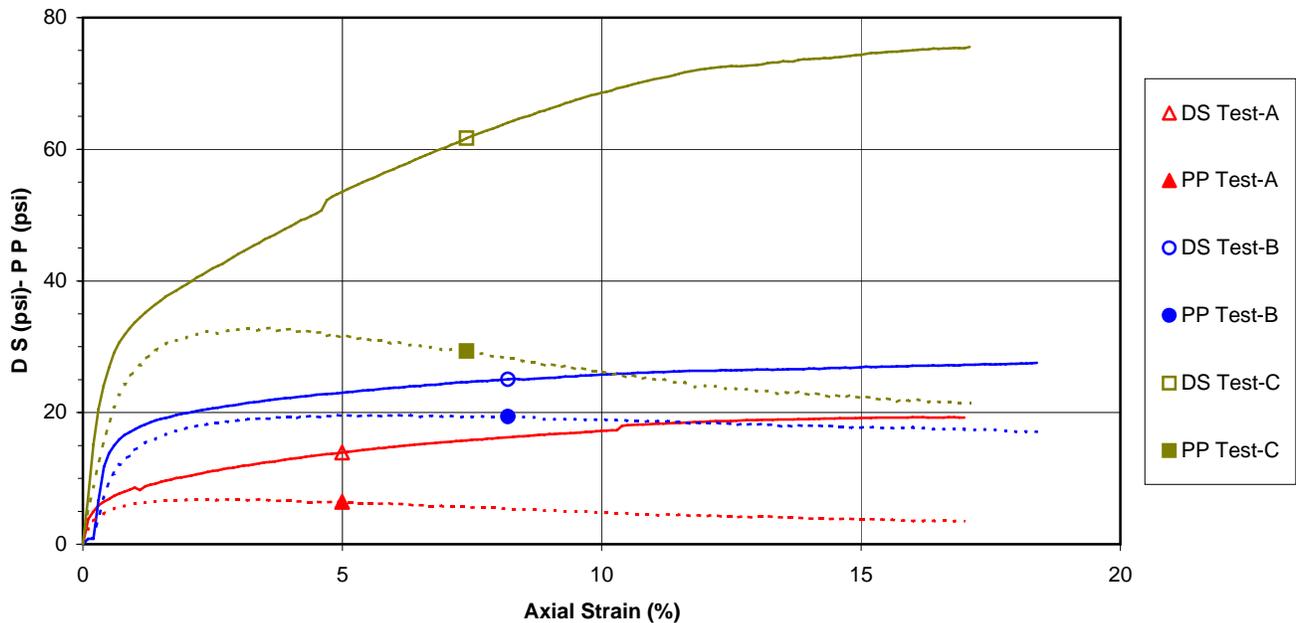
Project No. 175539022
 Test Number 2

Failure Criterion: $\phi' = 27.2 \text{ deg.}$ $c' = 320 \text{ psf}$
 Maximum Effective Principal Stress Ratio

p' vs. q Plot



Deviator Stress and Induced Pore Pressure vs. Axial Strain

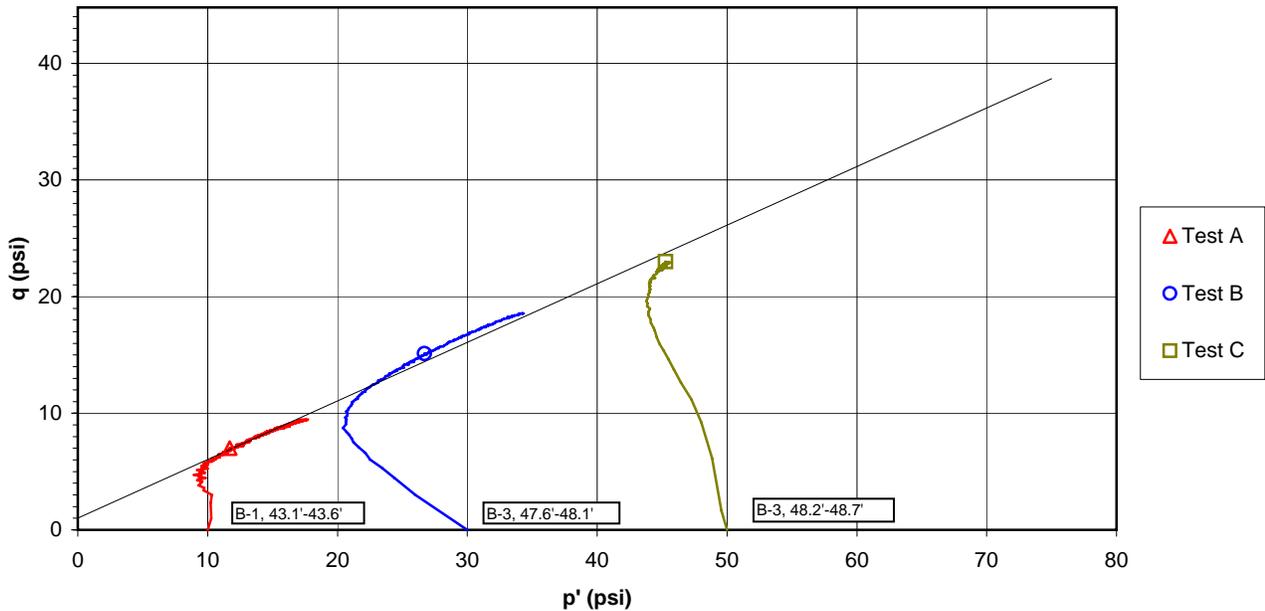


Project AEP-Clifty Creek-West Bottom Ash and Fly Ash Ponds subsurface exploration
 Sample ID B-1, 43.1'-43.6' & B-3, 47.6'-48.1' & B-3, 48.2'-48.7'

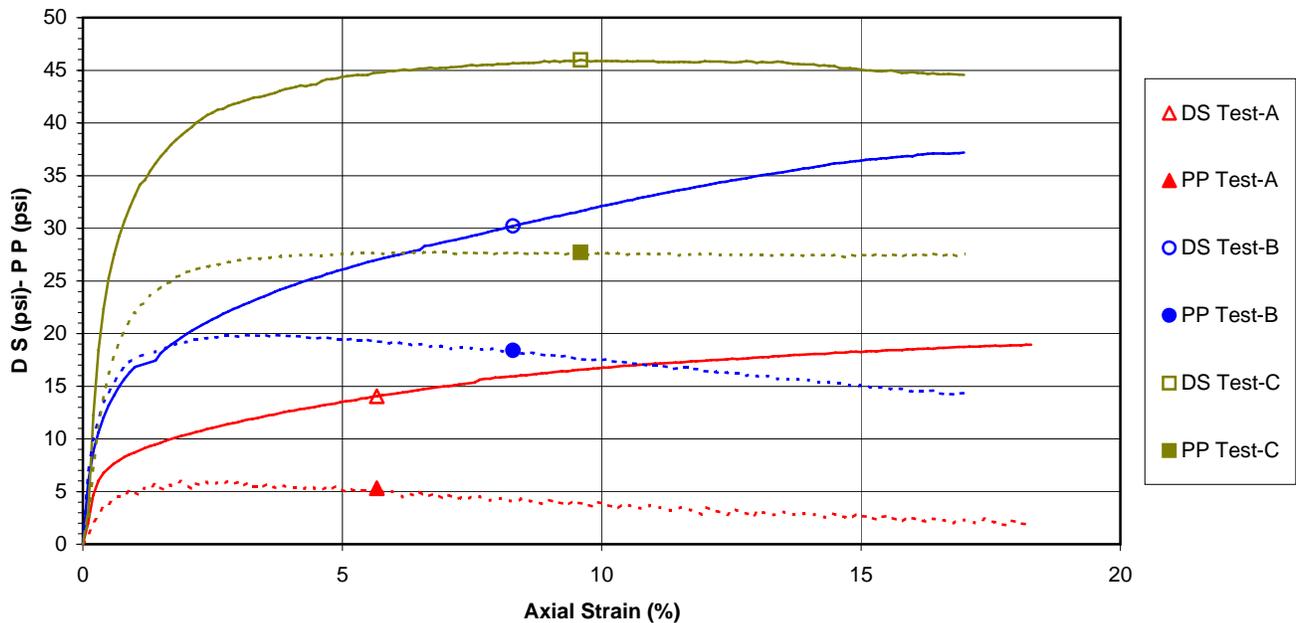
Project No. 175539022
 Test Number 3

Failure Criterion: $\phi' = 30.2 \text{ deg.}$ $c' = 170 \text{ psf}$
 Maximum Effective Principal Stress Ratio

p' vs. q Plot

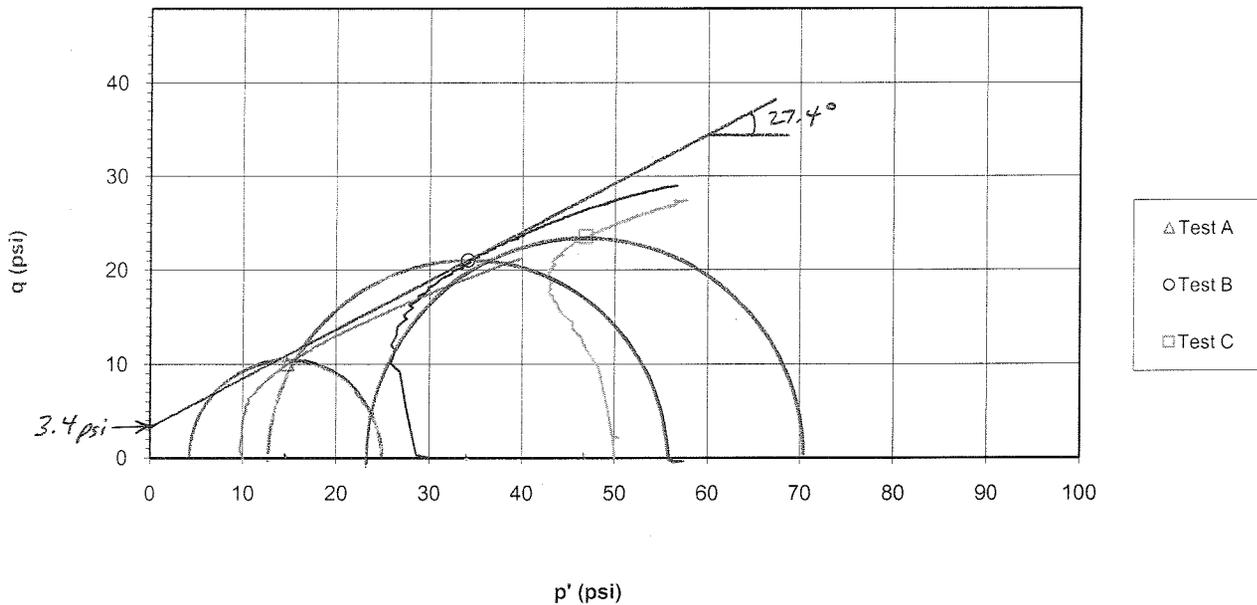
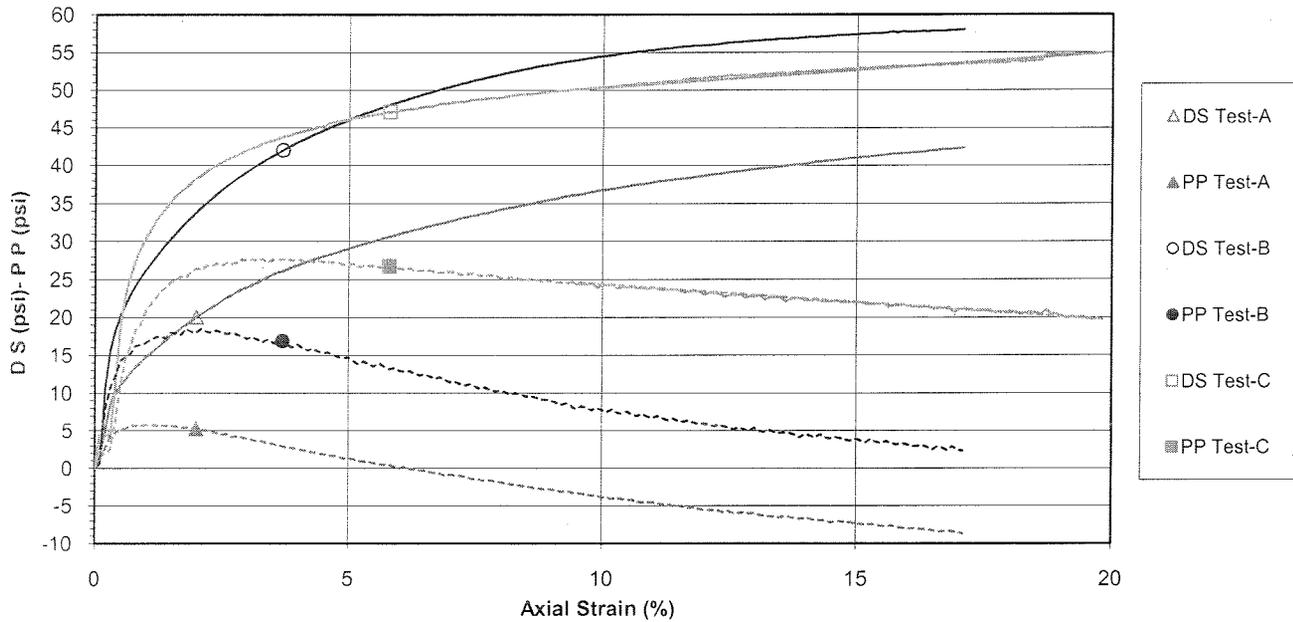


Deviator Stress and Induced Pore Pressure vs. Axial Strain



Project AEP-Clifty Creek-West Bottom and Fly Ash Ponds subsurface exploration
 Sample ID B-3, 10.7'-11.2' & B-3, 10.1'-10.6' & B-5, 8.1'-8.6'

 Project No. 175539022
 Test Number 1
 $\phi' = 27.4 \text{ deg.}$
 $c' = 490 \text{ psf}$
 Failure Criterion: Maximum Effective Principal Stress Ratio

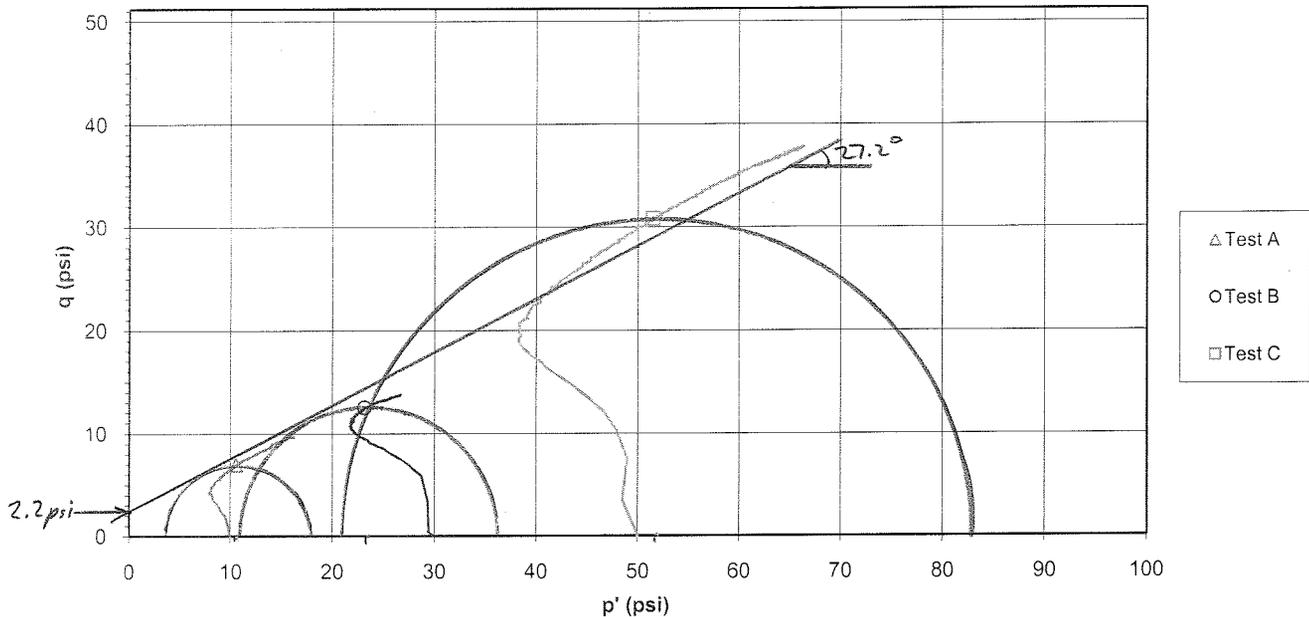
p' vs. q Plot

Deviator Stress and Induced Pore Pressure vs. Axial Strain


Project AEP-Clifty Creek-West Bottom Ash and Fly Ash Ponds subsurface exploration
 Sample ID B-2, 23.8'-24.3' & B-2, 22.7'-23.2' & B-4, 18.2'-18.7'

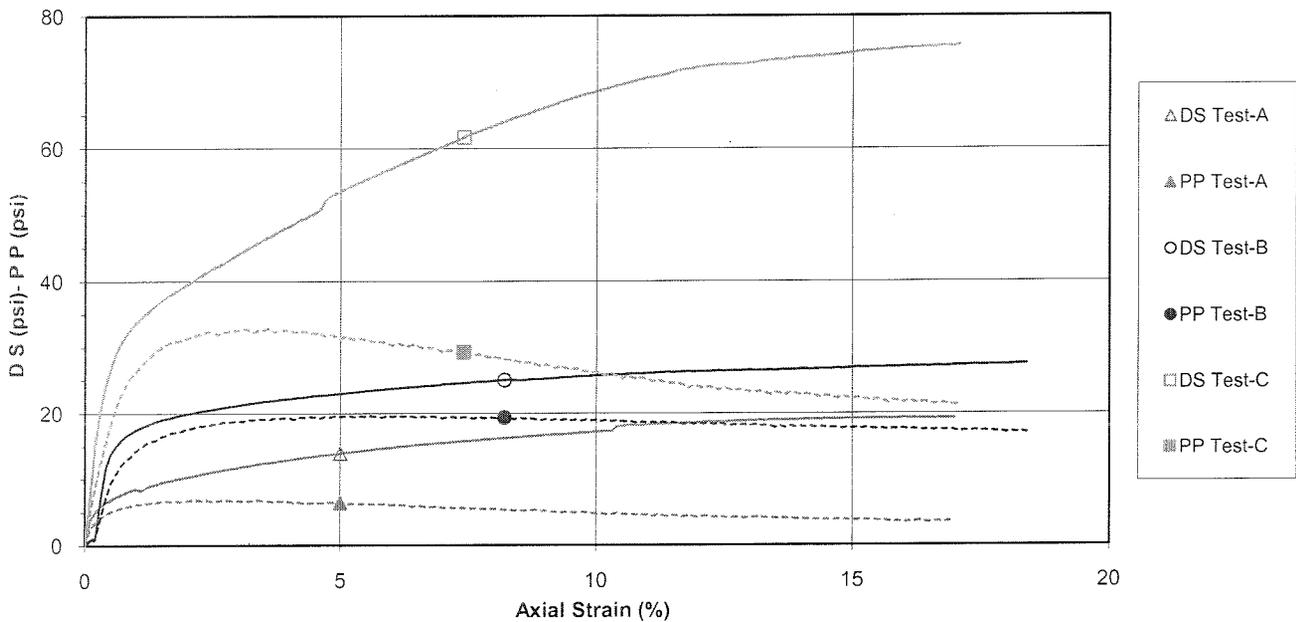
Project No. 175539022
 Test Number 2

Failure Criterion: $\phi' = 27.2 \text{ deg.}$ $c' = 320 \text{ psf}$
 Maximum Effective Principal Stress Ratio

p' vs. q Plot



Deviator Stress and Induced Pore Pressure vs. Axial Strain

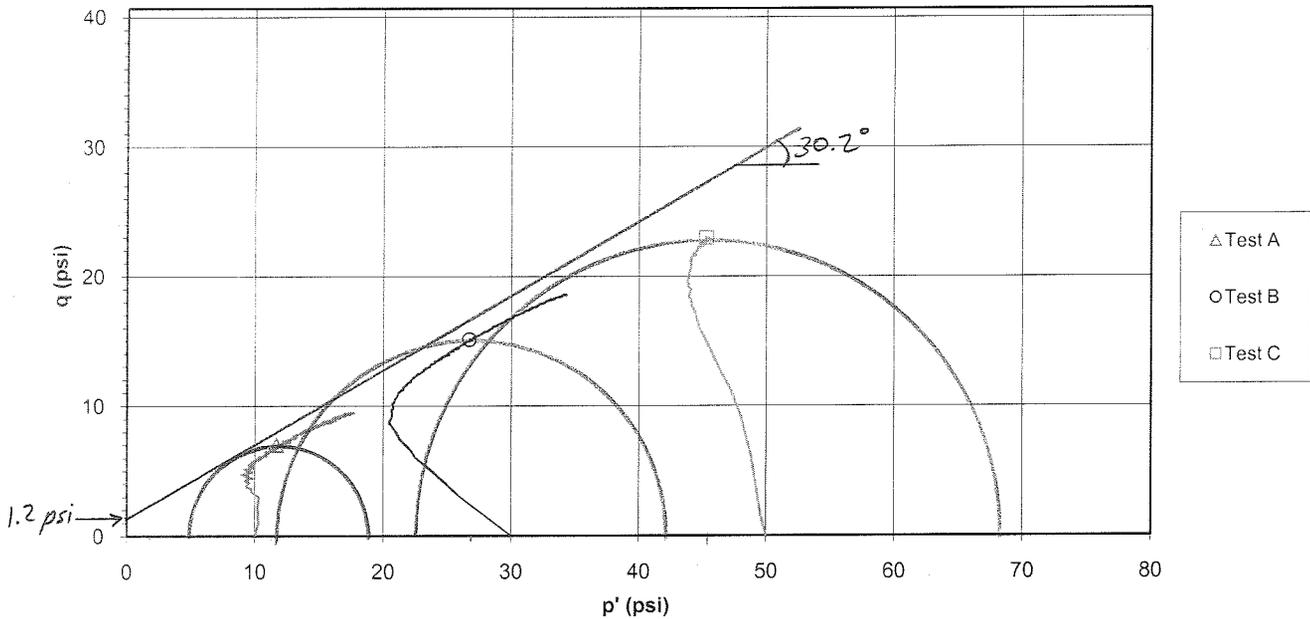


Project AEP-Clifty Creek-West Bottom Ash and Fly Ash Ponds subsurface exploration
 Sample ID B-1, 43.1'-43.6' & B-3, 47.6'-48.1' & B-3, 48.2'-48.7'

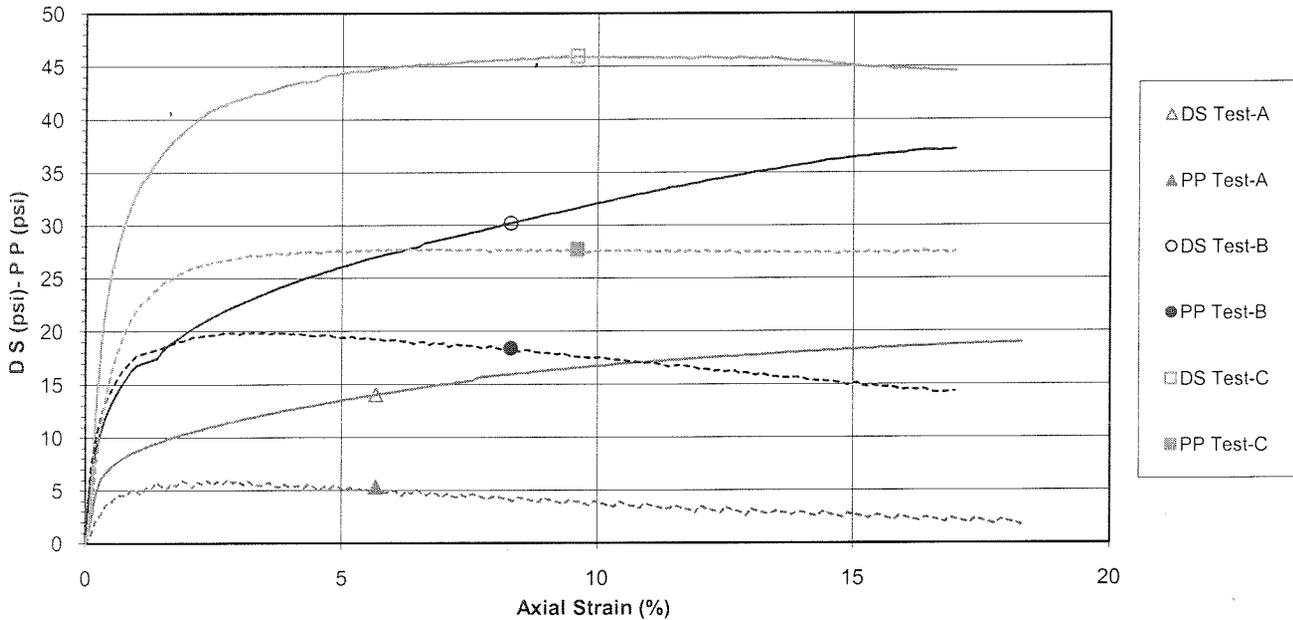
Project No. 175539022
 Test Number 3

Failure Criterion: $\phi' = 30.2 \text{ deg.}$ $c' = 170 \text{ psf}$
 Maximum Effective Principal Stress Ratio

p' vs. q Plot

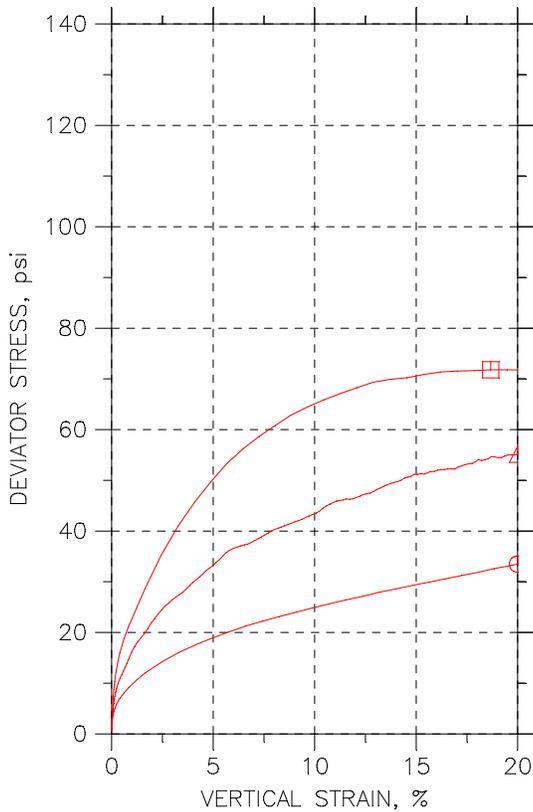
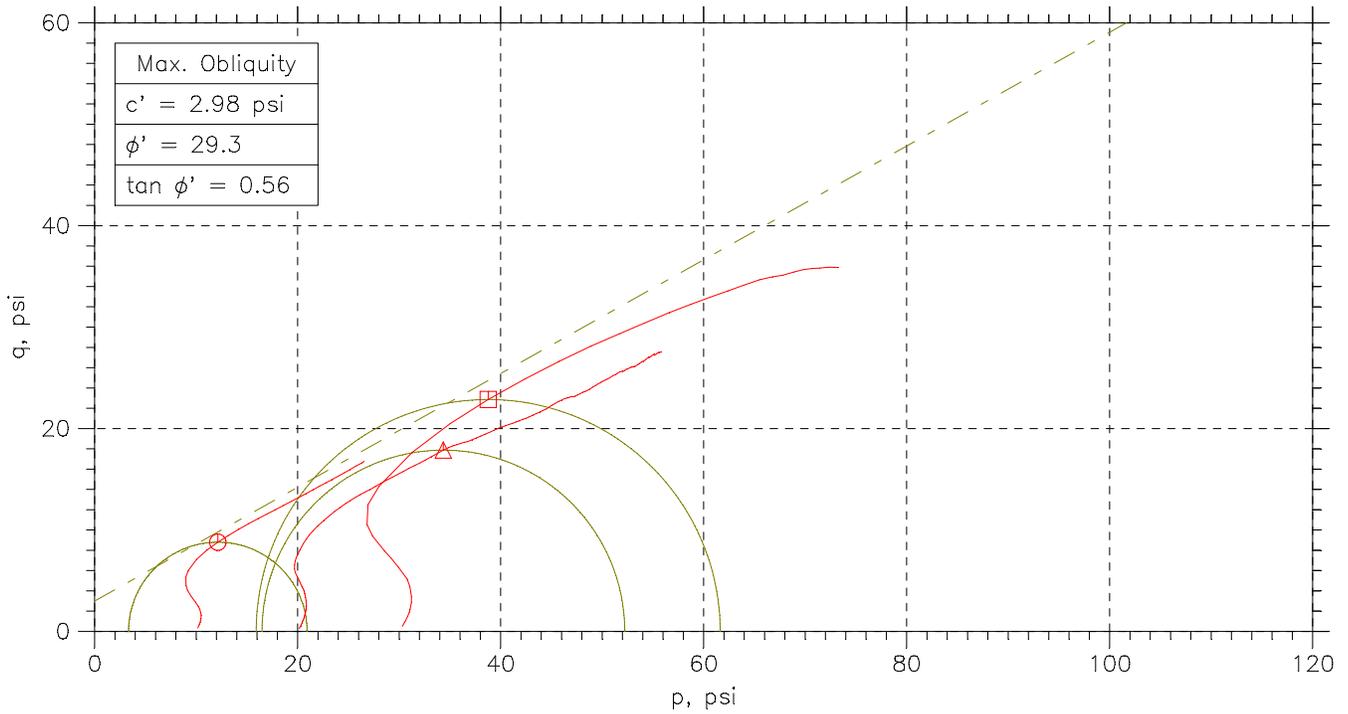


Deviator Stress and Induced Pore Pressure vs. Axial Strain



LANDFILL RUNOFF COLLECTION POND

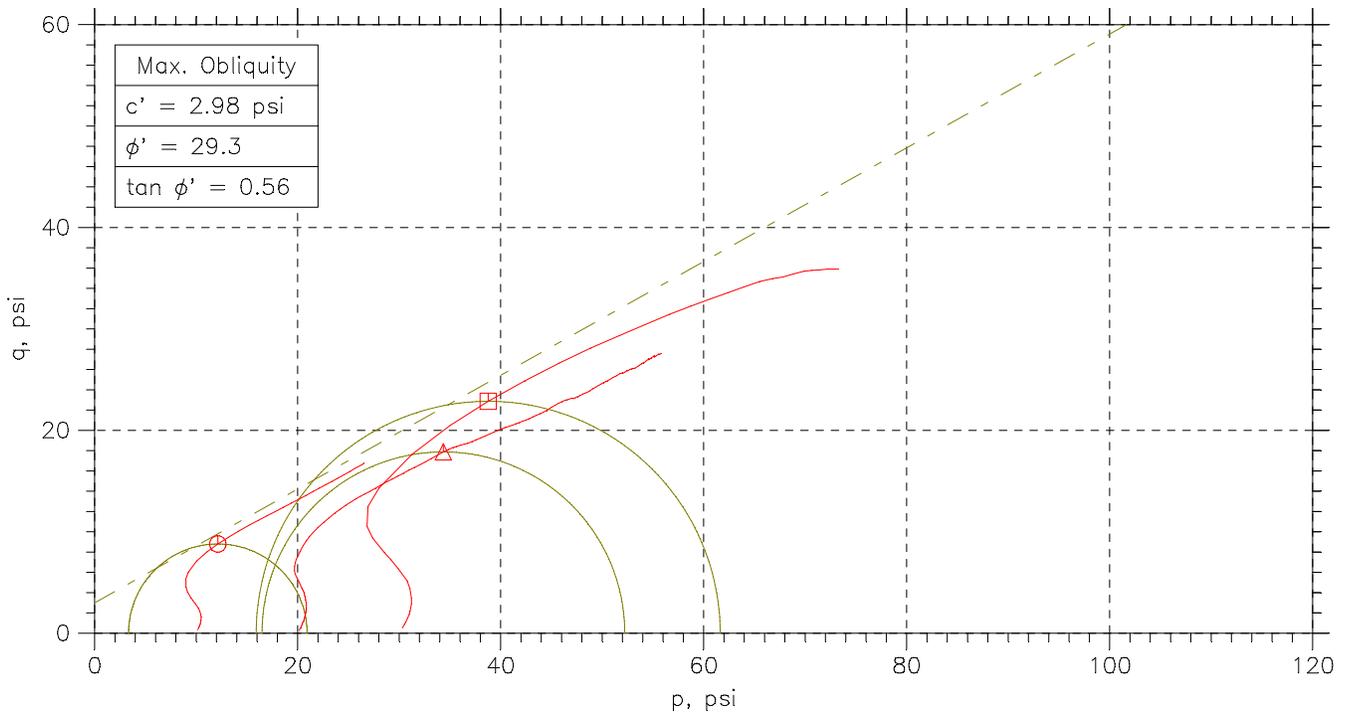
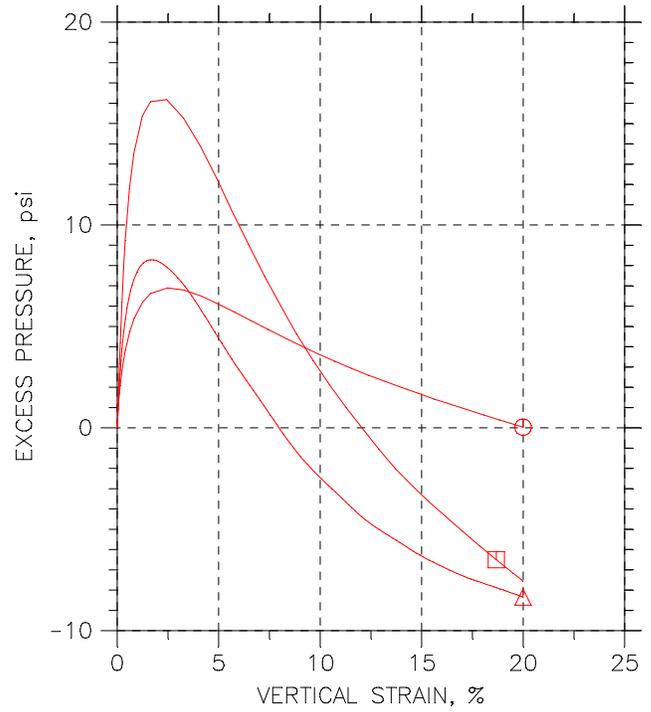
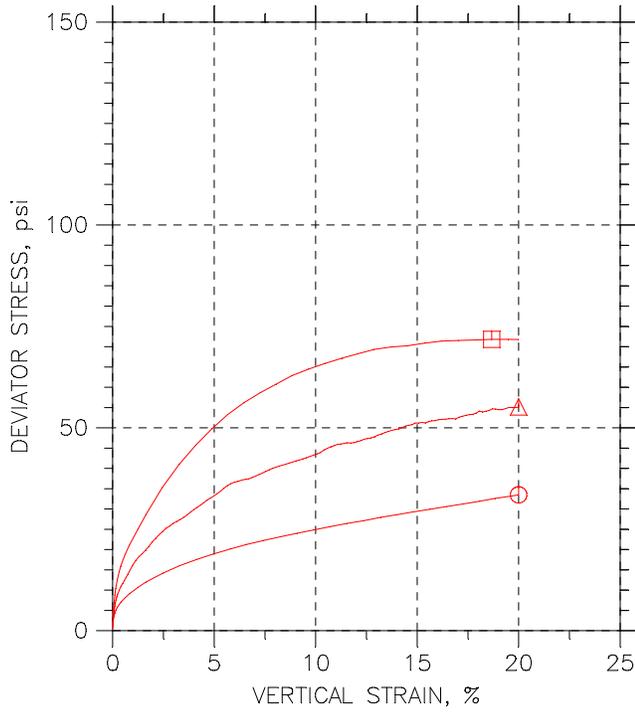
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



Symbol	⊙	△	□	
Sample No.	---	---	---	
Test No.	1.1	1.2	1.3	
Depth	25.8-26.0	26.4-27.0	28.4-29.0	
Initial	Diameter, in	2.835	2.834	2.832
	Height, in	6.314	5.928	5.929
	Water Content, %	20.2	21.0	19.0
	Dry Density, pcf	109.	107.5	111.3
	Saturation, %	99.8	99.6	99.7
	Void Ratio	0.546	0.568	0.515
Before Shear	Water Content, %	21.0	21.6	19.1
	Dry Density, pcf	107.7	106.5	111.2
	Saturation*, %	100.0	100.0	100.0
	Void Ratio	0.566	0.583	0.515
Back Press., psi	137.2	125.1	116.2	
Ver. Eff. Cons. Stress, psi	9.834	19.88	29.8	
Shear Strength, psi	16.74	27.57	35.9	
Strain at Failure, %	20	20	18.7	
Strain Rate, %/min	0.08	0.08	0.08	
B-Value	0.96	0.95	0.95	
Estimated Specific Gravity	2.7	2.7	2.7	
Liquid Limit	---	---	---	
Plastic Limit	---	---	---	

 <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek				
	Location: Jefferson, IN				
	Project No.: GTX-1516				
	Boring No.: B-7				
	Sample Type: UD				
	Description: Light Brown				
Remarks: System 1062					

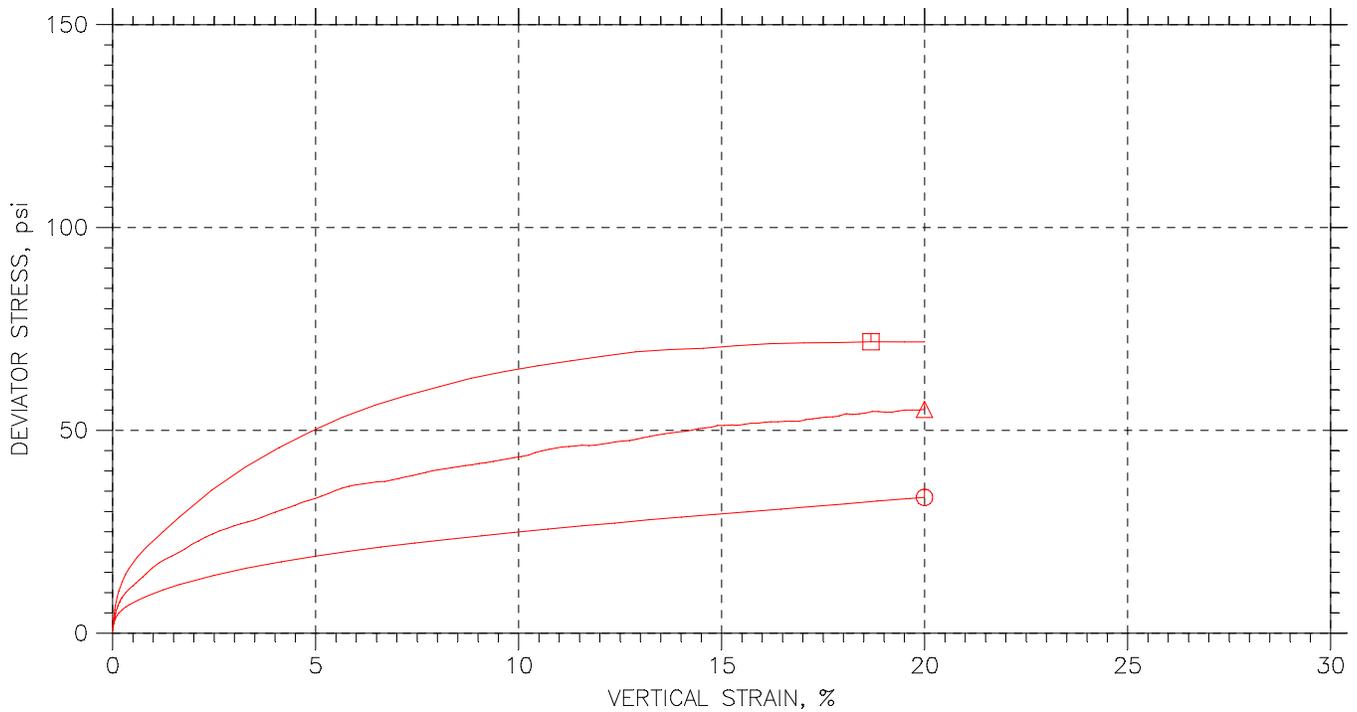
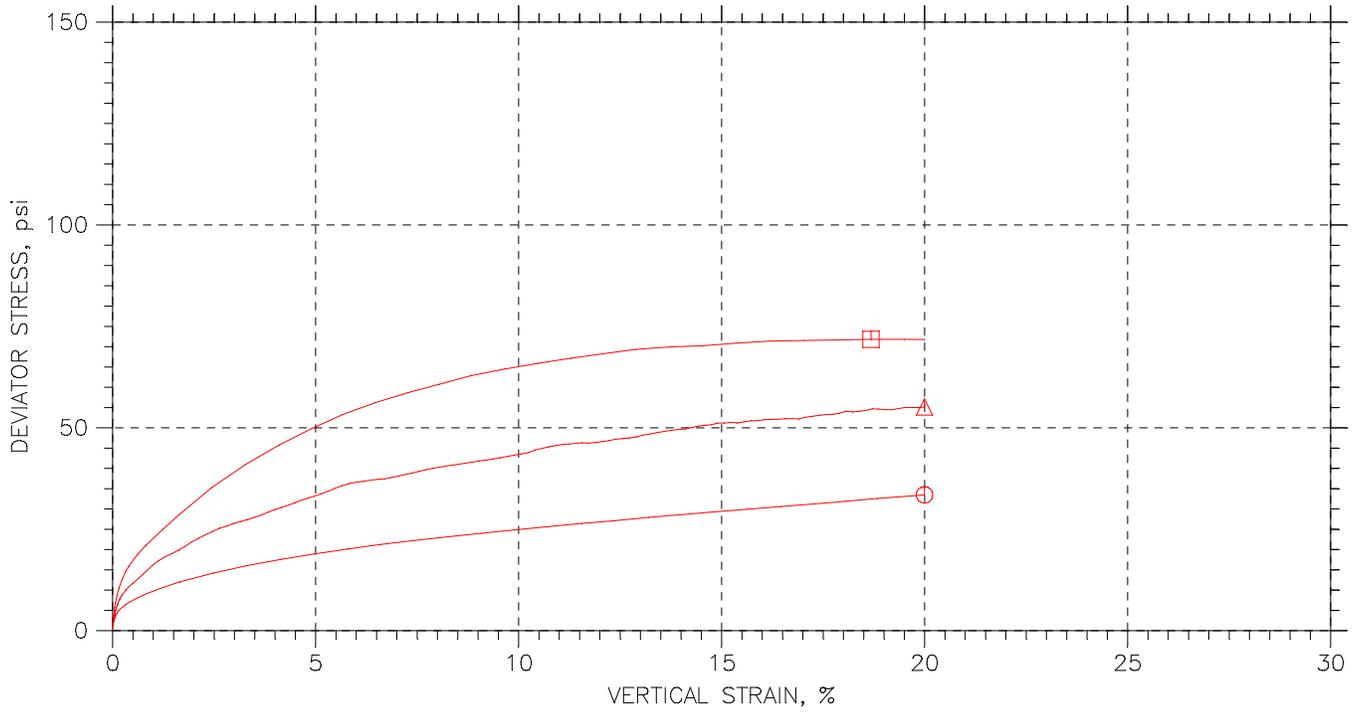
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



Symbol	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	1.1	25.8-26.0	jm	12/10/09	mm		1516-1.1.dat
△	---	1.2	26.4-27.0	jm	12/10/09	mm		1516-1.2.dat
□	---	1.3	28.4-29.0	jm	12/9/09	mm		1516-1.3.dat

<p style="font-size: small; margin-top: 5px;">a subsidiary of Geocomp Corporation</p>	Project: Clifty Creek	Location: Jefferson, IN	Project No.: GTX-1516
	Boring No.: B-7	Sample Type: UD	
	Description: Light Brown		
	Remarks: System 1062		

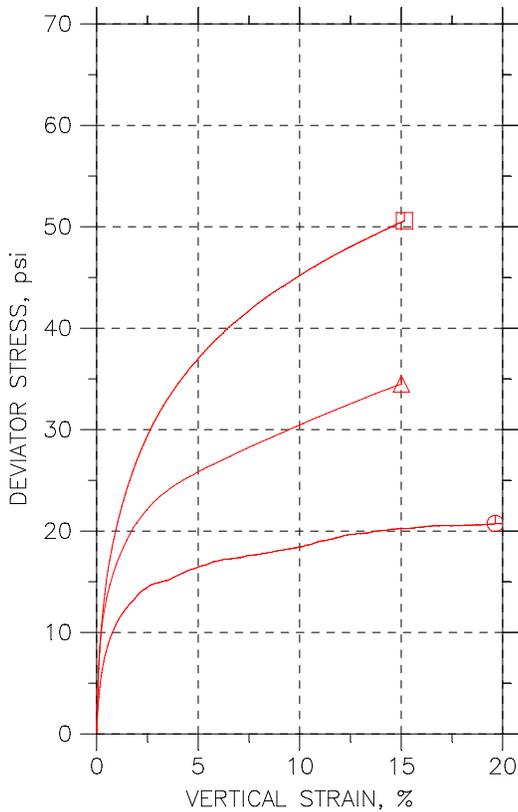
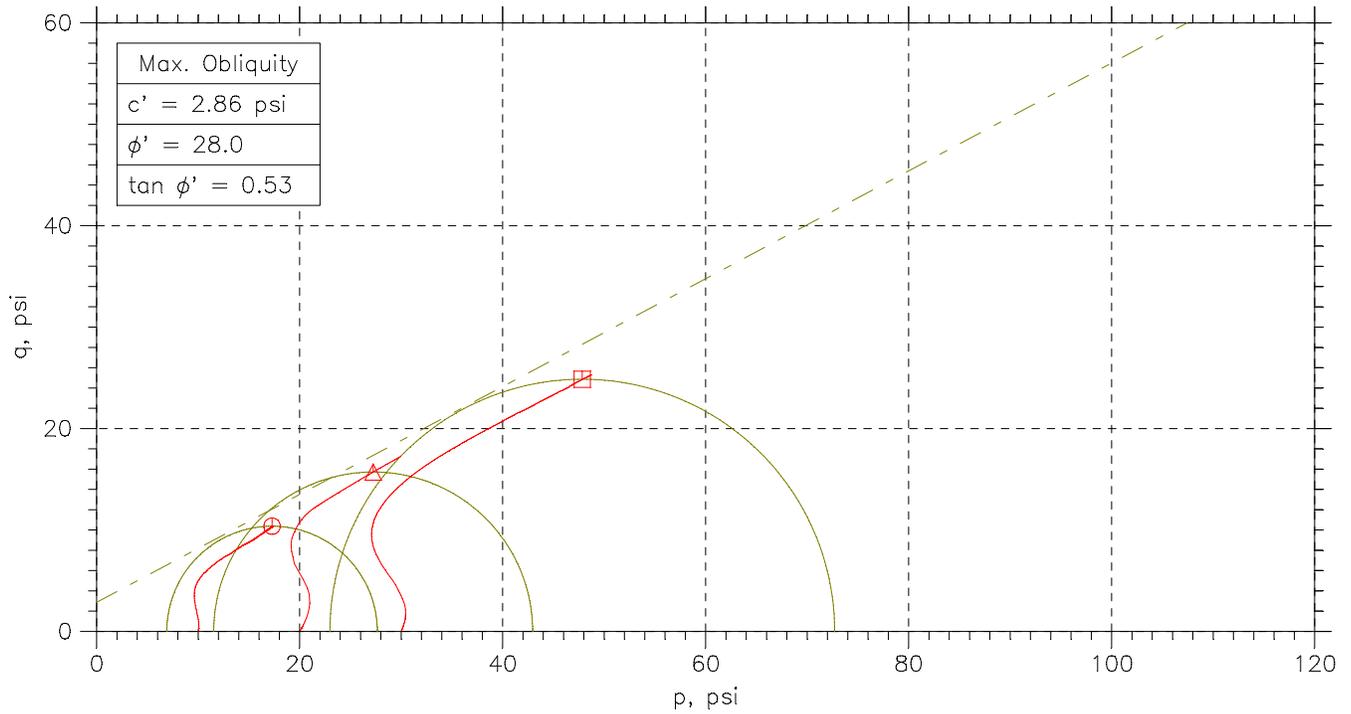
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	1.1	25.8-26.0	jm	12/10/09	mm		1516-1.1.dat
△	---	1.2	26.4-27.0	jm	12/10/09	mm		1516-1.2.dat
□	---	1.3	28.4-29.0	jm	12/9/09	mm		1516-1.3.dat

 <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek		Location: Jefferson, IN		Project No.: GTX-1516	
	Boring No.: B-7		Sample Type: UD			
	Description: Light Brown					
	Remarks: System 1062					

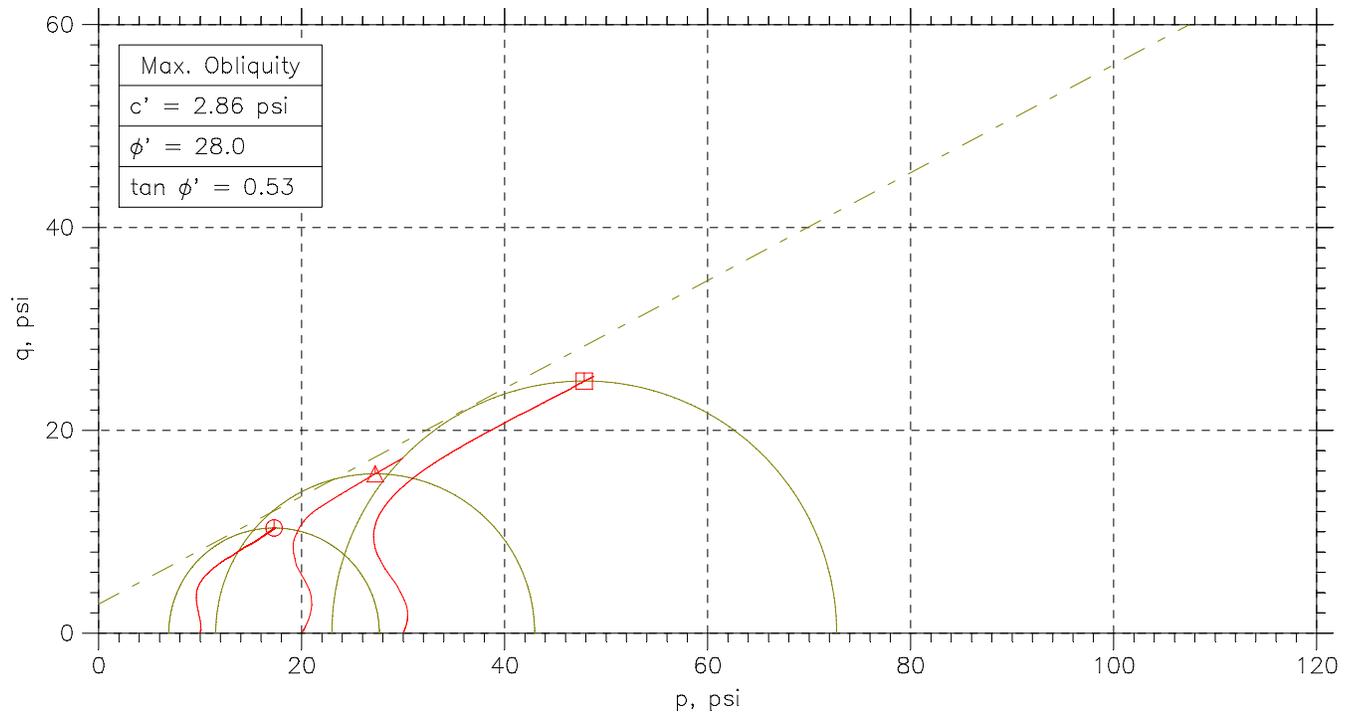
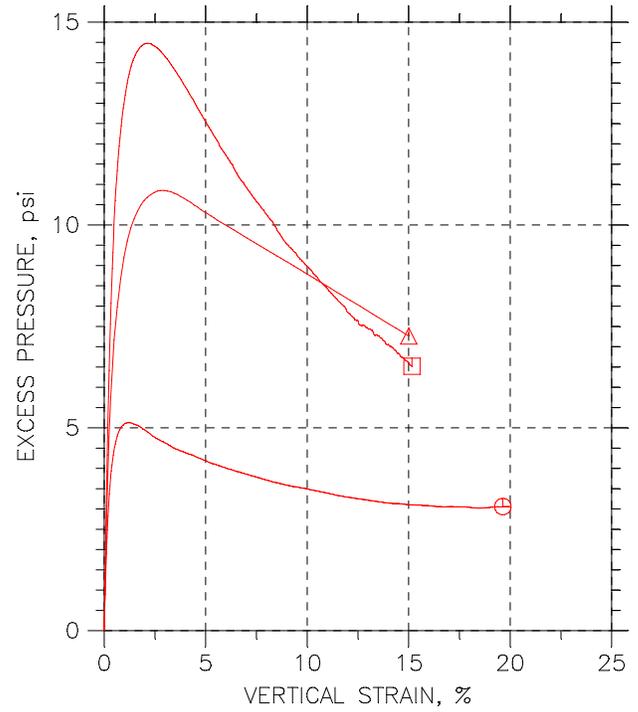
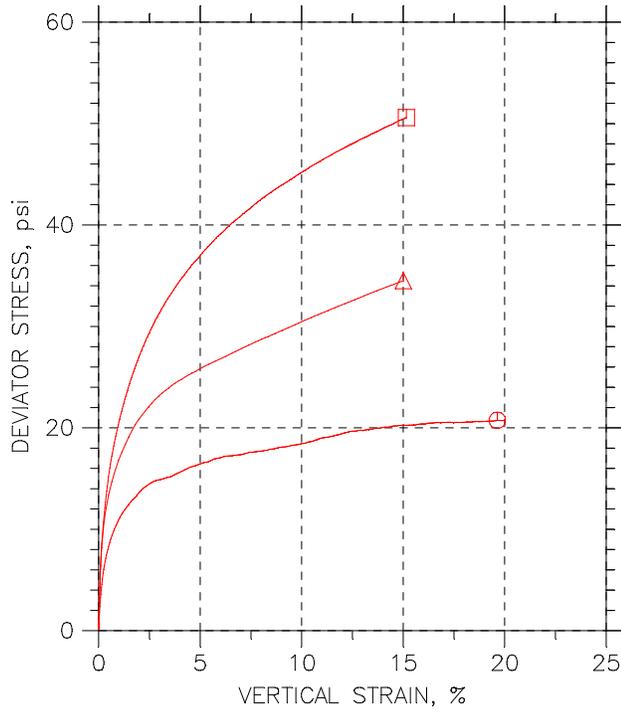
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



Symbol	⊙	△	□	
Sample No.	---	---	---	
Test No.	2.1	2.2	2.3	
Depth	25.8-26.4'	28.4-29.0'	30.3-30.9'	
Initial	Diameter, in	2.82	2.824	2.838
	Height, in	5.82	6.027	6.001
	Water Content, %	21.0	20.7	20.9
	Dry Density, pcf	107.2	107.6	107.6
	Saturation, %	99.2	98.7	99.6
Before Shear	Void Ratio	0.572	0.567	0.567
	Water Content, %	20.5	19.8	19.0
	Dry Density, pcf	108.5	109.8	111.4
	Saturation*, %	100.0	100.0	100.0
	Void Ratio	0.554	0.535	0.513
	Back Press., psi	59.25	124.8	56.31
	Ver. Eff. Cons. Stress, psi	9.968	19.98	29.96
	Shear Strength, psi	10.37	17.25	25.3
	Strain at Failure, %	19.6	15	15.2
	Strain Rate, %/min	0.016	0.016	0.016
	B-Value	0.95	0.96	0.95
	Estimated Specific Gravity	2.7	2.7	2.7
	Liquid Limit	---	---	---
	Plastic Limit	---	---	---

 <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek			
	Location: Jefferson, IN.			
	Project No.: GTX-1516			
	Boring No.: B-8			
	Sample Type: UD			
	Description: Greenish brown lean clay with sand			
Remarks: 2054				

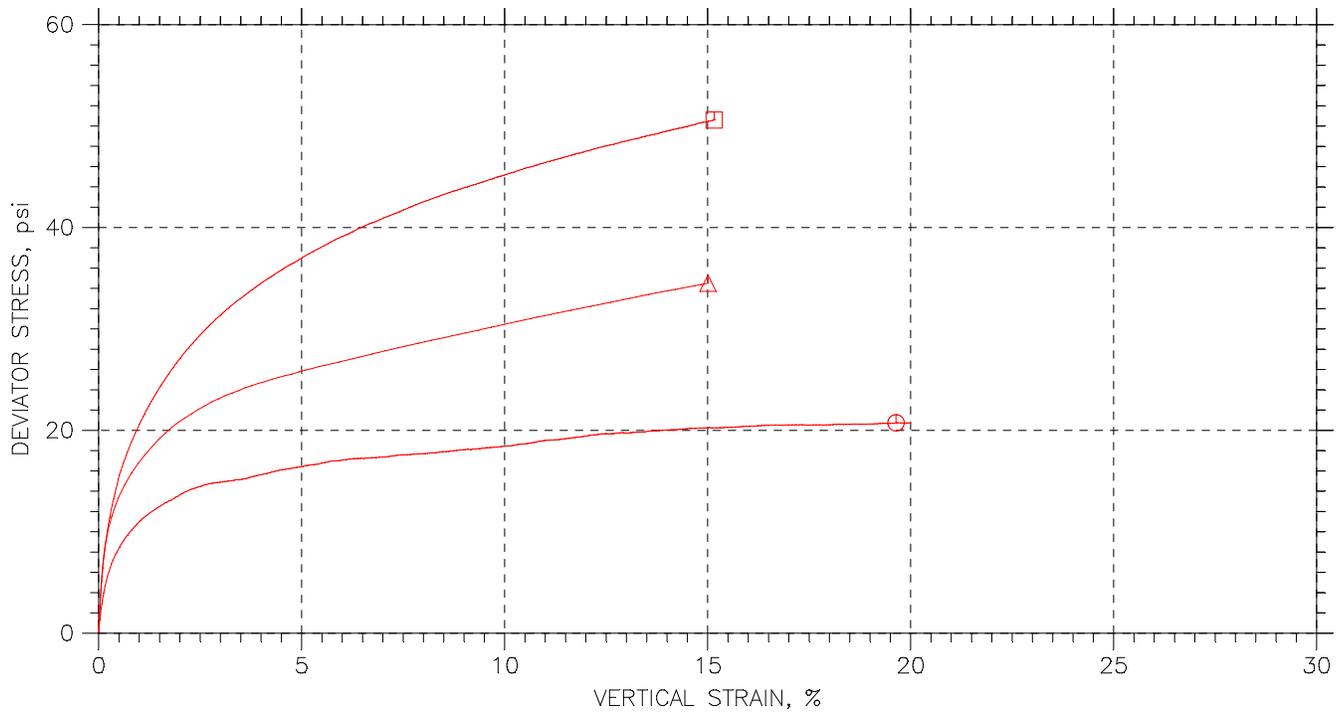
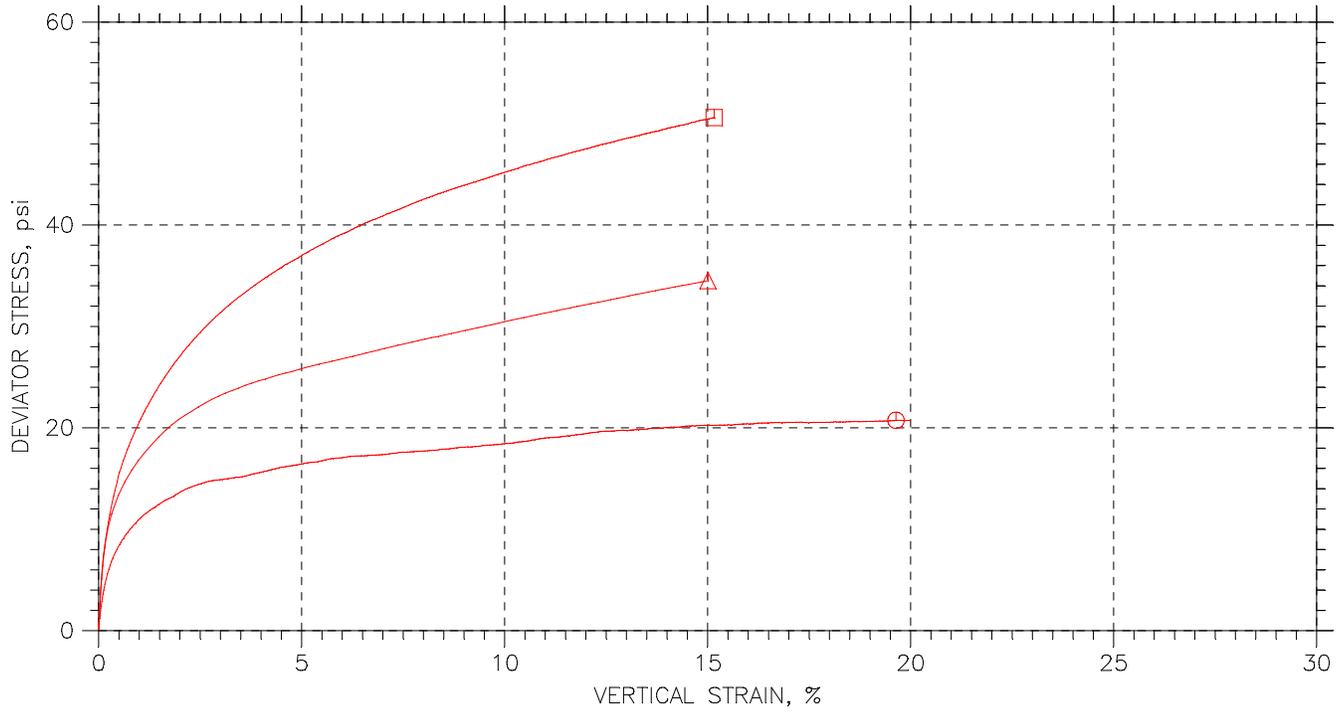
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	2.1	25.8-26.4	jm	12/11/09	mm		1516-2.1.dat
△	---	2.2	28.4-29.0	jm	12/11/09	mm		1516-2.2A.dat
□	---	2.3	30.3-30.9'	jm	12/09/09	mm		1516-2.3.dat

 <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek		Location: Jefferson, IN.		Project No.: GTX-1516	
	Boring No.: B-8		Sample Type: UD			
	Description: Greenish brown lean clay with sand					
	Remarks: 2054					

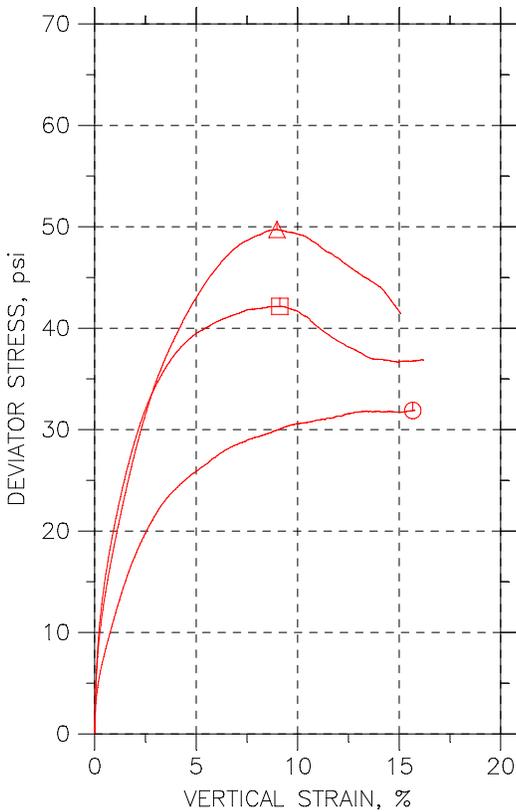
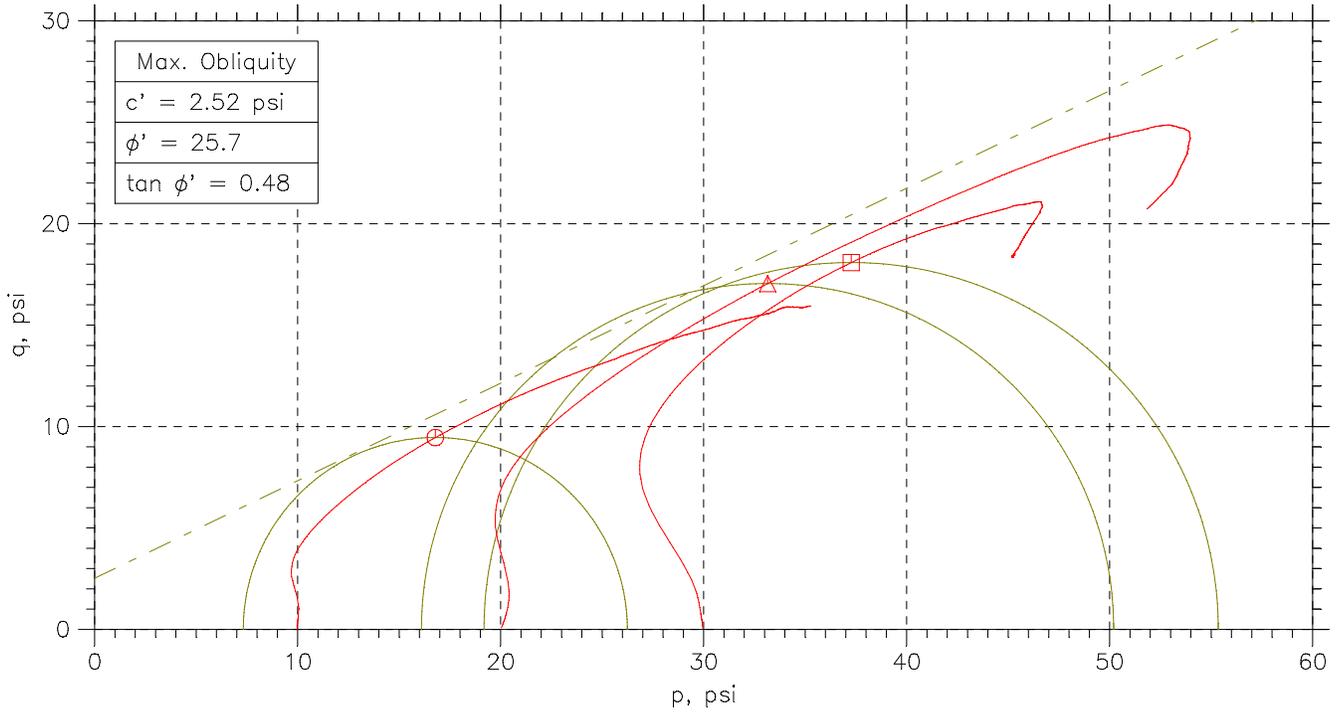
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	2.1	25.8-26.4	jm	12/11/09	mm		1516-2.1.dat
△	---	2.2	28.4-29.0	jm	12/11/09	mm		1516-2.2A.dat
□	---	2.3	30.3-30.9'	jm	12/09/09	mm		1516-2.3.dat

 <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek		Location: Jefferson, IN.		Project No.: GTX-1516	
	Boring No.: B-8		Sample Type: UD			
	Description: Greenish brown lean clay with sand					
	Remarks: 2054					

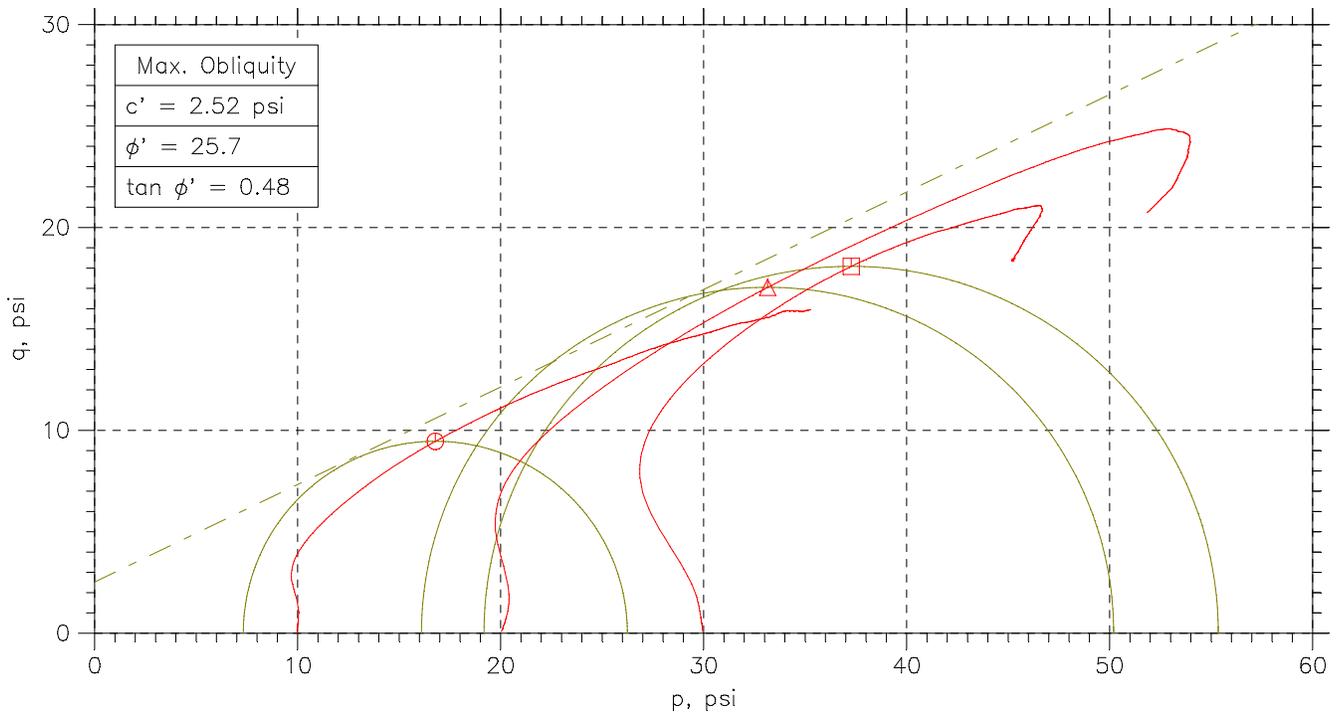
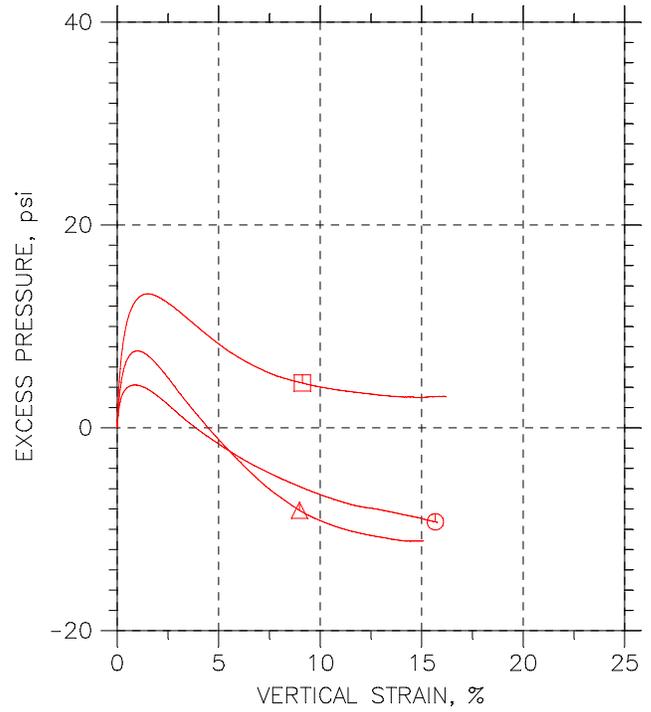
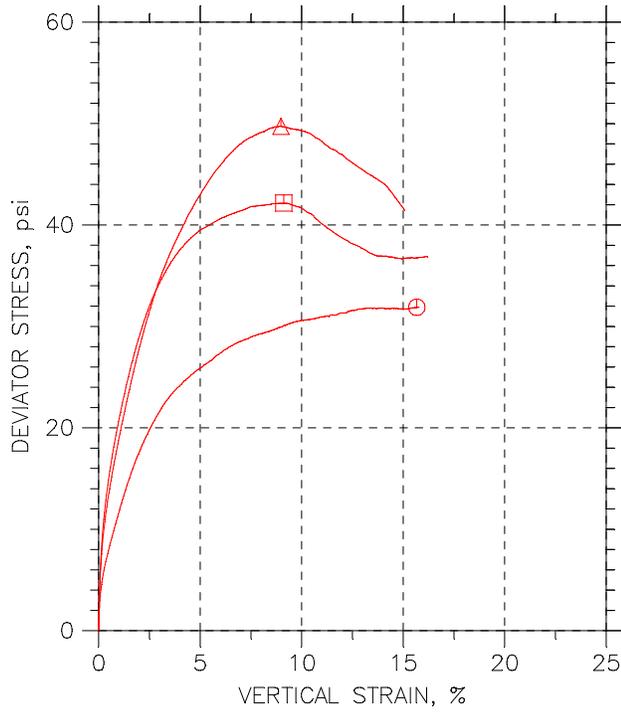
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



Symbol	⊕	△	□	
Sample No.	---	---	---	
Test No.	3.1	3.2	3.3	
Depth	17.4-18.0	19.4-20.0	20.8--21.4	
Initial	Diameter, in	2.835	2.835	2.837
	Height, in	6.319	6.281	6.177
	Water Content, %	19.4	18.4	20.8
	Dry Density, pcf	109.7	111.4	107.3
	Saturation, %	97.8	96.9	98.6
Before Shear	Void Ratio	0.536	0.514	0.571
	Water Content, %	19.2	18.9	22.7
	Dry Density, pcf	111.	111.7	104.5
	Saturation*, %	100.0	100.0	100.0
	Void Ratio	0.518	0.509	0.613
	Back Press., psi	136.8	122	116.2
	Ver. Eff. Cons. Stress, psi	9.997	19.96	29.88
	Shear Strength, psi	15.94	24.86	21.08
	Strain at Failure, %	15.7	8.98	9.12
	Strain Rate, %/min	0.016	0.016	0.016
	B-Value	0.95	0.96	0.95
	Estimated Specific Gravity	2.7	2.7	2.7
	Liquid Limit	---	---	---
	Plastic Limit	---	---	---

 <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek				
	Location: Jefferson, IN				
	Project No.: GTX-1516				
	Boring No.: B-9				
	Sample Type: UD				
	Description: Brown lean clay with sand				
Remarks: System 1057					

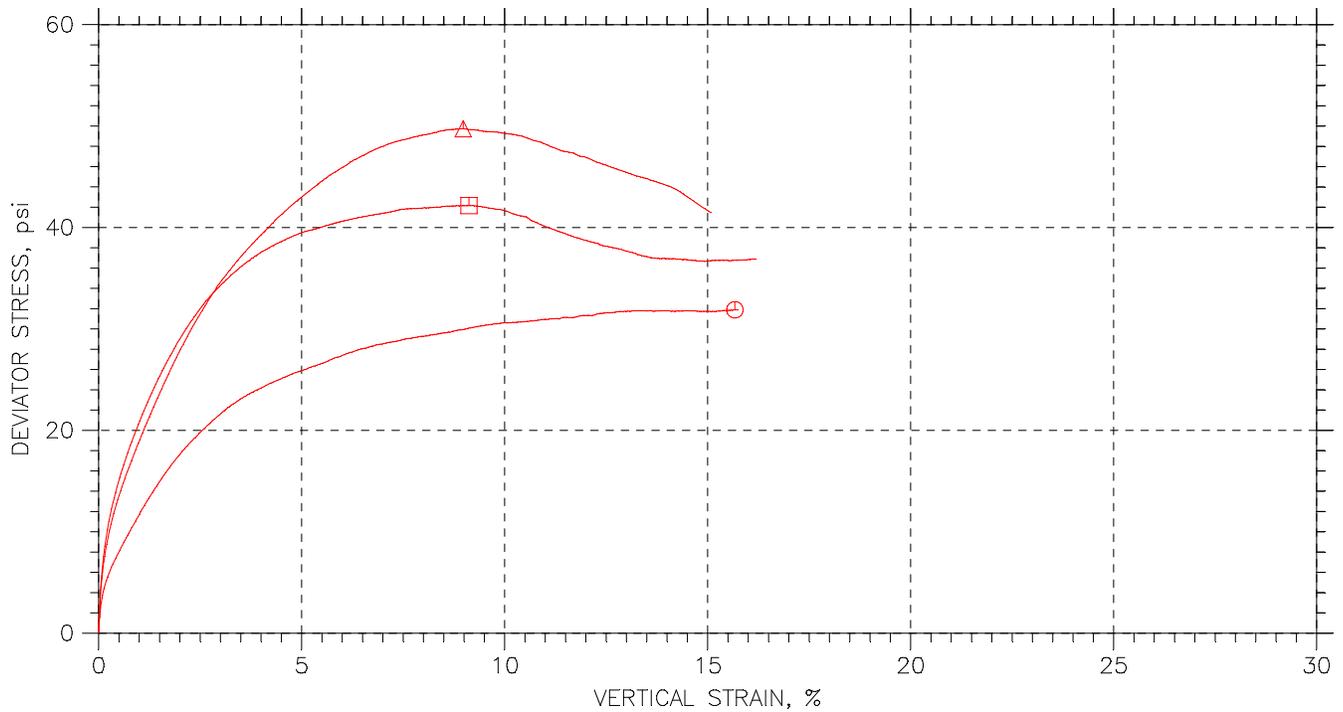
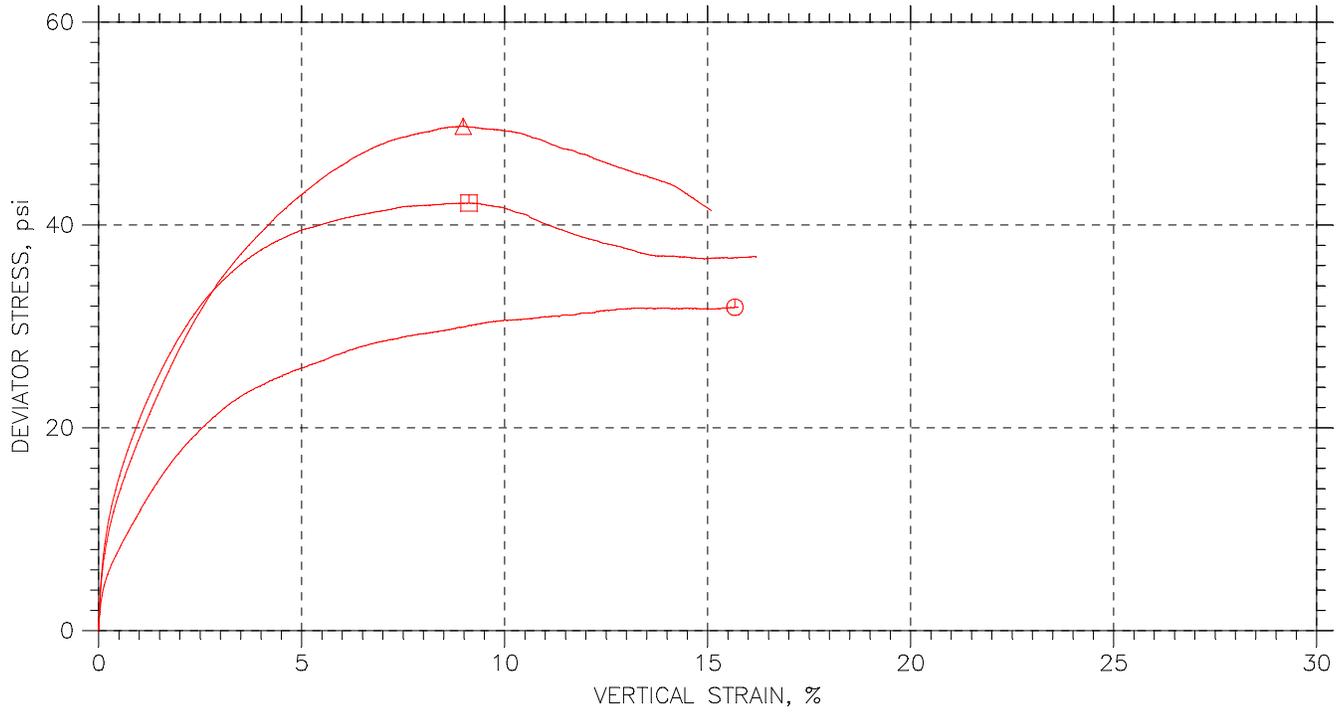
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	3.1	17.4-18.0	jm	12/15/09	mm		1516-3.1.dat
△	---	3.2	19.4-20.0	jm	12/16/09	mm		1516-3.2Adat.dat
□	---	3.3	20.8--21.4	jm	12/10/09	mm		1516-3.3.dat

 <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek		Location: Jefferson, IN		Project No.: GTX-1516	
	Boring No.: B-9		Sample Type: UD			
	Description: Brown lean clay with sand					
	Remarks: System 1057					

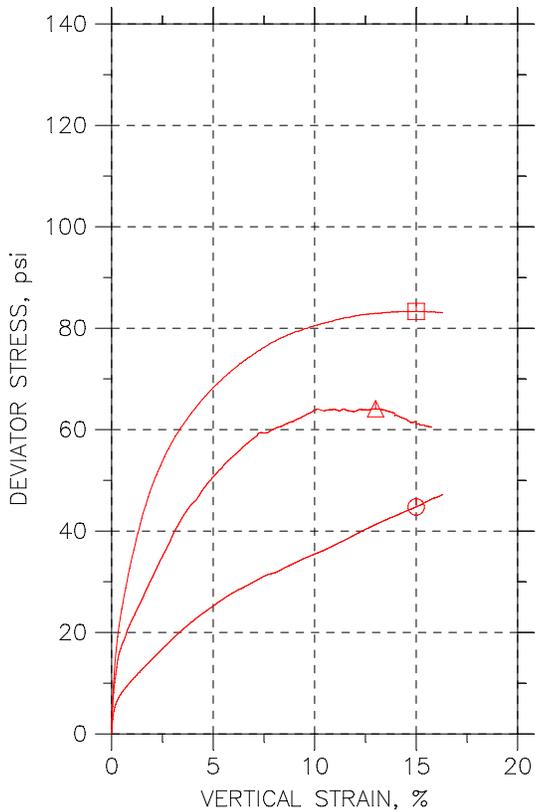
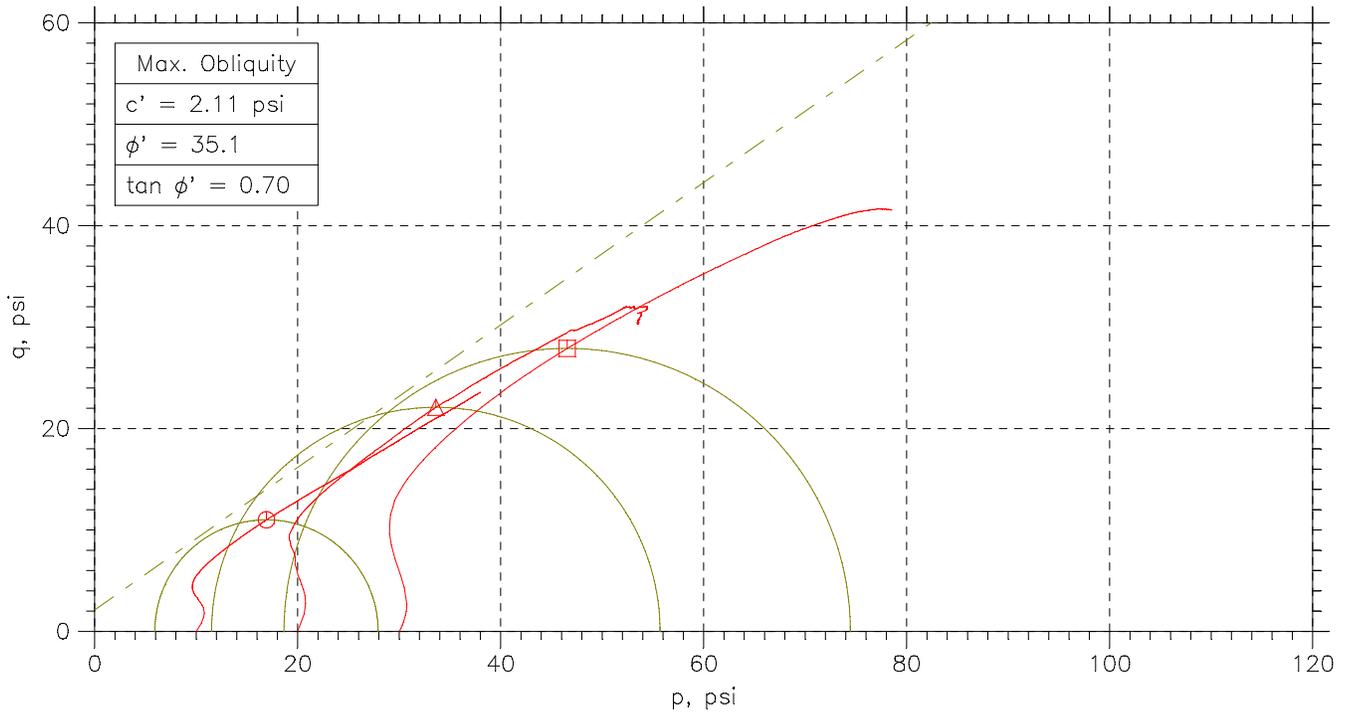
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	3.1	17.4-18.0	jm	12/15/09	mm		1516-3.1.dat
△	---	3.2	19.4-20.0	jm	12/16/09	mm		1516-3.2Adat.dat
□	---	3.3	20.8--21.4	jm	12/10/09	mm		1516-3.3.dat

 <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek		Location: Jefferson, IN		Project No.: GTX-1516	
	Boring No.: B-9		Sample Type: UD			
	Description: Brown lean clay with sand					
	Remarks: System 1057					

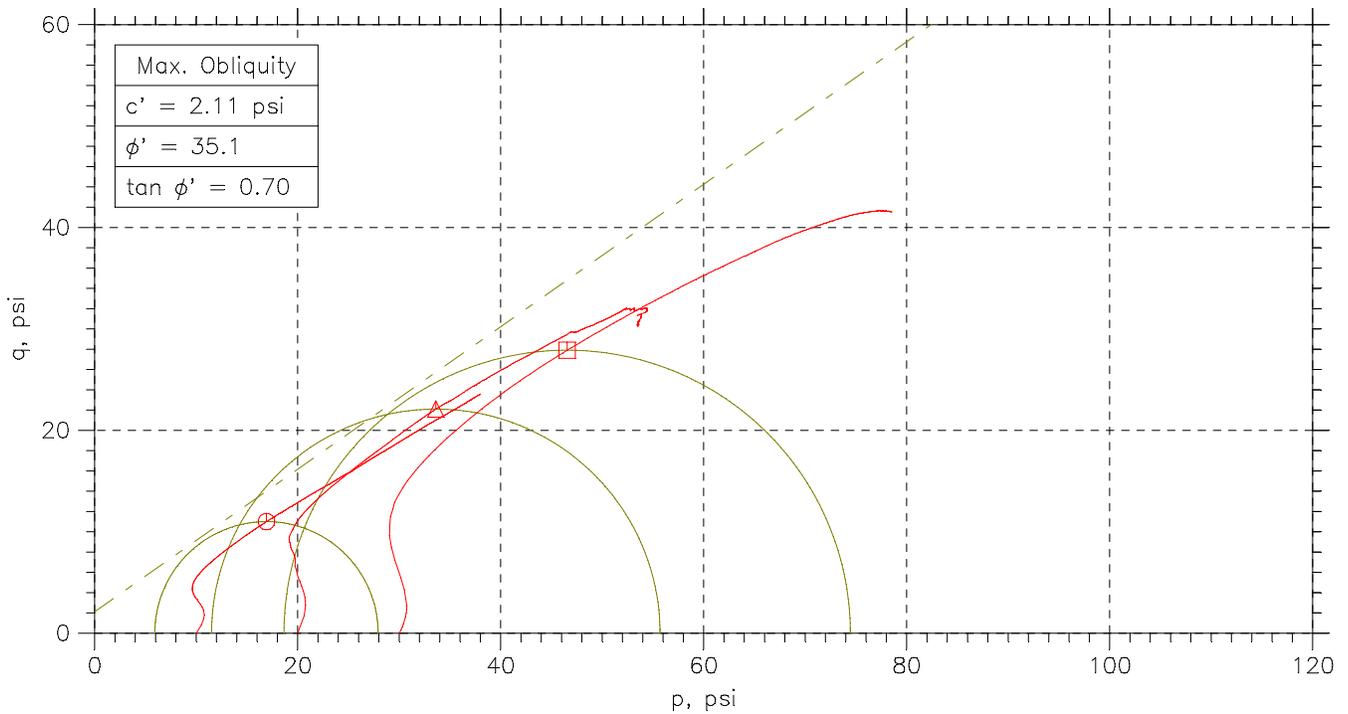
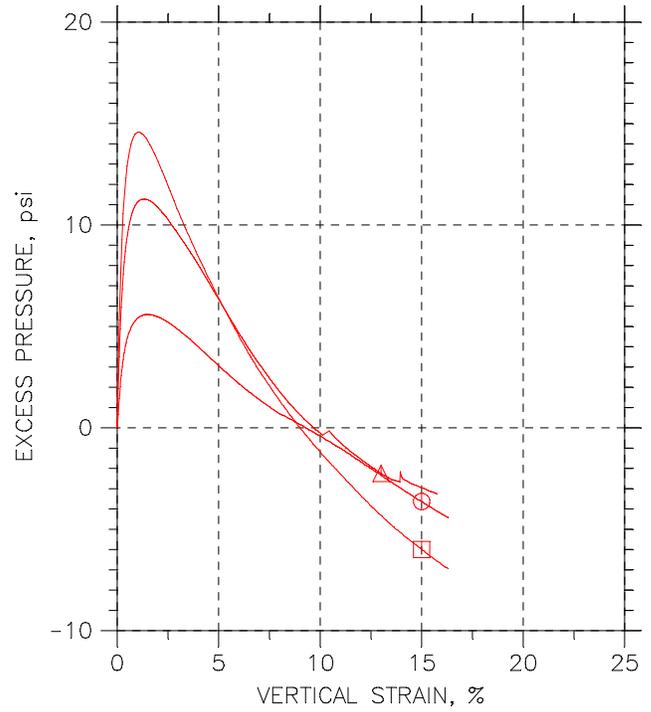
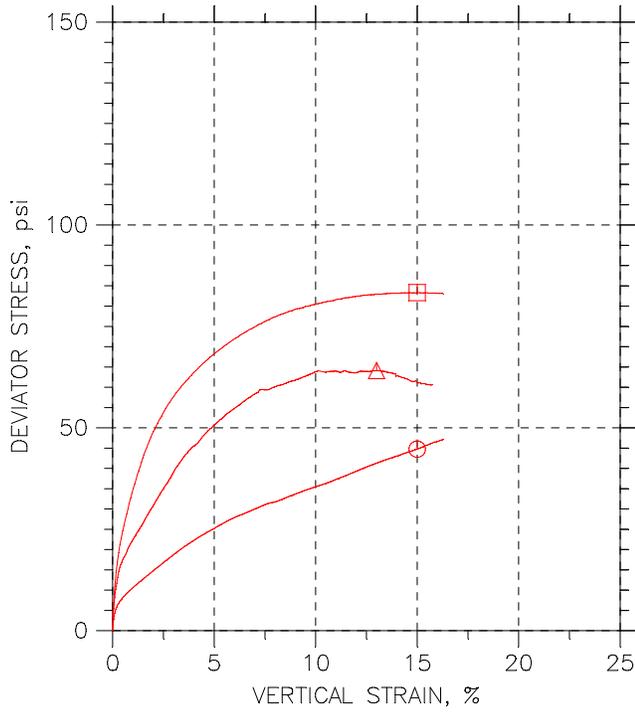
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



Symbol	⊗	△	□	
Sample No.	---	----	----	
Test No.	CU-4.1	CU-4.2	CU-4.3	
Depth	13.4-14.0'	16.8-17.4'	17.4-18.'	
Initial	Diameter, in	2.83	2.71	2.72
	Height, in	5.78	5.52	5.51
	Water Content, %	14.2	27.4	26.6
	Dry Density, pcf	102.9	93.8	93.72
	Saturation, %	59.9	93.0	89.9
Before Shear	Void Ratio	0.638	0.797	0.798
	Water Content, %	23.2	18.5	19.2
	Dry Density, pcf	103.7	112.4	111.
	Saturation*, %	100.0	100.0	100.0
	Void Ratio	0.625	0.5	0.519
	Back Press., psi	27.99	73	84.99
	Ver. Eff. Cons. Stress, psi	10	19.99	30
	Shear Strength, psi	22.37	32.06	41.66
	Strain at Failure, %	15	13	15
	Strain Rate, %/min	0.032	0.032	0.032
	B-Value	0.95	0.95	0.96
	Estimated Specific Gravity	2.7	2.7	2.7
	Liquid Limit	---	---	---
	Plastic Limit	---	---	---

 <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek				
	Location: ----				
	Project No.: GTX-1516				
	Boring No.: B-10				
	Sample Type: UD				
	Description:				
Remarks: 2054					

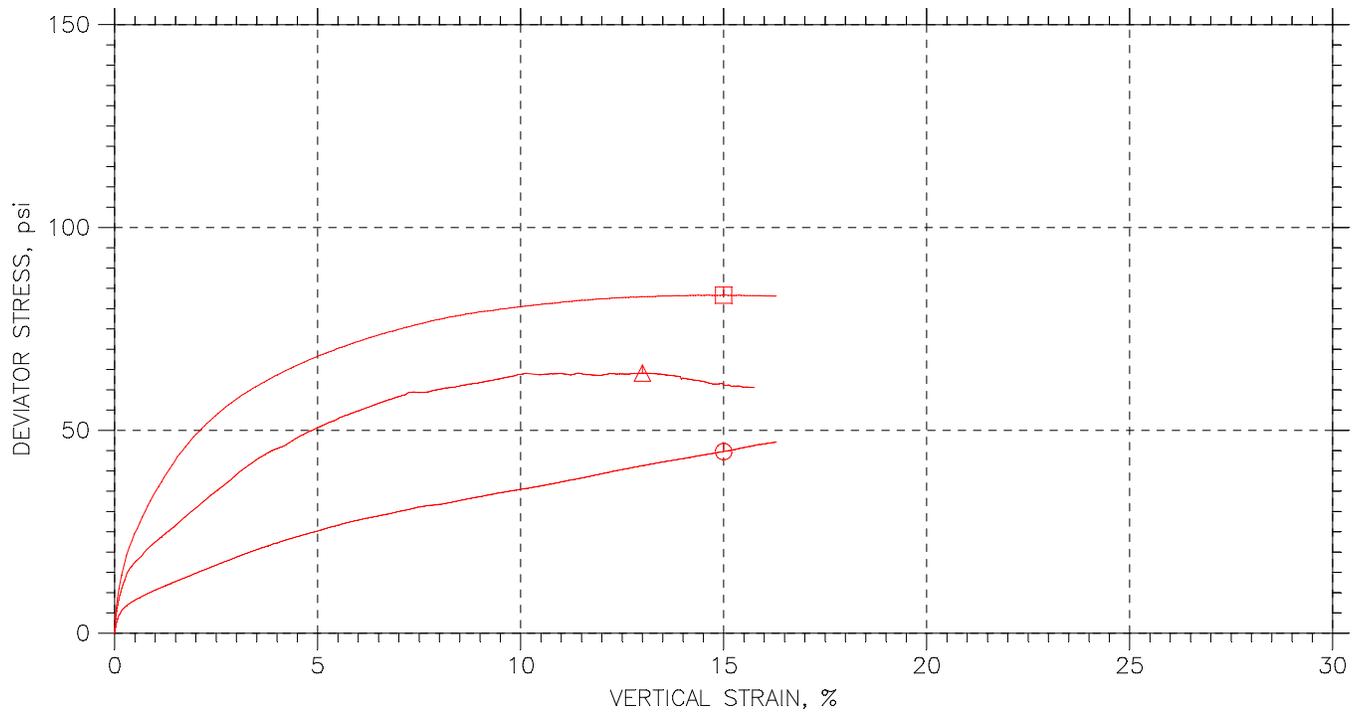
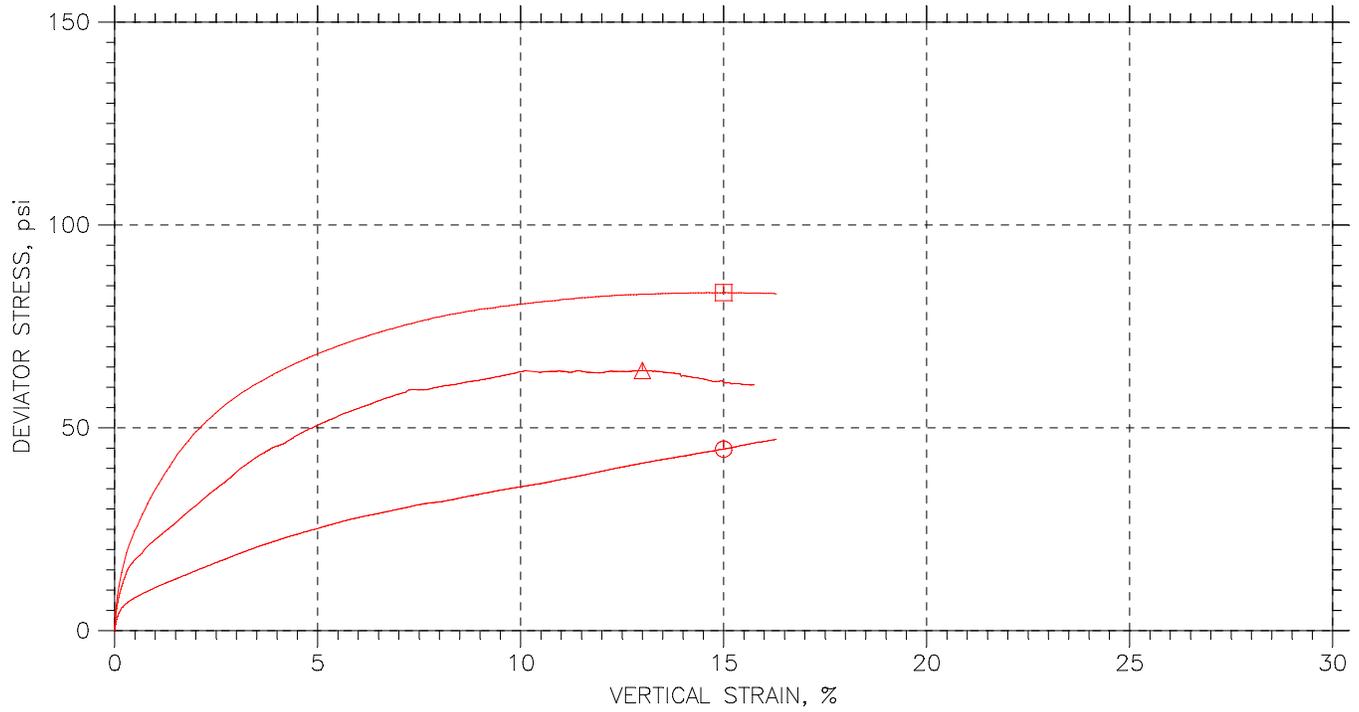
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	CU-4.1	13.4-14.0'	JM	12/12/09	MM		1516-4.1.dat
△	----	CU-4.2	16.8-17.4'	JM	12/13/09	MM		1516-4.2.dat
□	----	CU-4.3	17.4-18.'	JM	12/12/09	MM		1516-4.3.dat

 <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek		Location: ----		Project No.: GTX-1516	
	Boring No.: B-10		Sample Type: UD			
	Description:					
	Remarks: 2054					

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	CU-4.1	13.4-14.0'	JM	12/12/09	MM		1516-4.1.dat
△	----	CU-4.2	16.8-17.4'	JM	12/13/09	MM		1516-4.2.dat
□	----	CU-4.3	17.4-18.'	JM	12/12/09	MM		1516-4.3.dat

 <p style="font-size: small;">a subsidiary of Geocomp Corporation</p>	Project: Clifty Creek		Location: ----		Project No.: GTX-1516	
	Boring No.: B-10		Sample Type: UD			
	Description:					
	Remarks: 2054					

APPENDIX F

PERMEABILITY TESTS

BOILER SLAB POND DAM



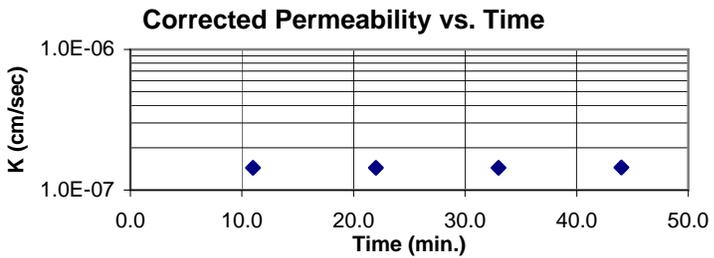
Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter ASTM D 5084-03

Project Name AEP-Clifty Creek-West Bottom Ash and Fly Ash Ponds subsurface exploration Project No. 175539022
 Source B-1, 15.0'-17.0', T1 16.1'-16.6' Test ID 7A
 Visual Classification Lean Clay (CL), brown, moist, firm Prepared By CSM
 Undisturbed XX Specific Gravity 2.72 ASTM D854-A Date 12-9-09
 Maximum Dry Density (pcf) _____ Percent of Maximum _____
 Permeant: De-aired tap water
 Selection and Preparation Comments: _____

Specimens (if compacted) were compacted in a Proctor Mold as follows: The Maximum Dry Density was converted to Wet Density, this mass was divided by 4 (layers) and 3 of the 4 layers were compacted into the mold using a Proctor Hammer using 19 blows per layer. The density was varied by reducing the height of the drop by the amount listed beside "Compacted". The specimen was trimmed from the bottom two layers.

	Initial Specimen Data	After Consolidation Data	After Test Data	Final Pressures (psi)	
Height (in.)	1.4783	1.4675	1.4676	Chamber <u>75</u>	
Diameter (in.)	2.8043		2.8179	Influent <u>70</u>	
Moisture Content (%)	19.7		20.8	Effluent <u>65</u>	Applied Head Difference (psi) <u>5</u>
Dry Unit Weight (pcf)	109.5		109.2		Back Pressure Saturated to (psi) <u>65</u>
Void Ratio	0.551		0.555		Maximum Effective Consolidation Stress (psi) <u>10</u>
Degree of Saturation (%)	97.3		101.9		Minimum Effective Consolidation Stress (psi) <u>5</u>
Trimmings MC (%)	19.6				

Date	Clock (24H:M)	Temp. °F	Bottom Head	Top Head	Test Time (sec)	Hydraulic Conductivity			
						k (m/s)	k (cm/s)	k @ 20° C (m/s)	k @ 20° C (cm/s)
12-21-09	10:24	73.0	15.02	8.57	0	---	---	---	---
12-21-09	10:35	73.0	14.90	8.69	6.60E+02	1.5E-09	1.5E-07	1.4E-09	1.4E-07
12-21-09	10:46	73.0	14.78	8.81	6.60E+02	1.5E-09	1.5E-07	1.4E-09	1.4E-07
12-21-09	10:57	73.0	14.66	8.93	6.60E+02	1.5E-09	1.5E-07	1.4E-09	1.4E-07
12-21-09	11:08	73.0	14.54	9.05	6.60E+02	1.5E-09	1.5E-07	1.4E-09	1.4E-07



A gradient of approximately 93.4 was used for this test. This gradient exceeds ASTM guidelines for maximum gradient, but was used to achieve the requestors desired test duration. Examination of the sample shows no signs of material loss or clogging that may affect test results.

Average Hydraulic Conductivity @ 20° C (last 4 determinations) m/s 1.44E-09 cm/s 1.44E-07
 Average Hydraulic Conductivity @ 20° C (last run) m/s 1.44E-09 cm/s 1.44E-07

Reviewed by: _____



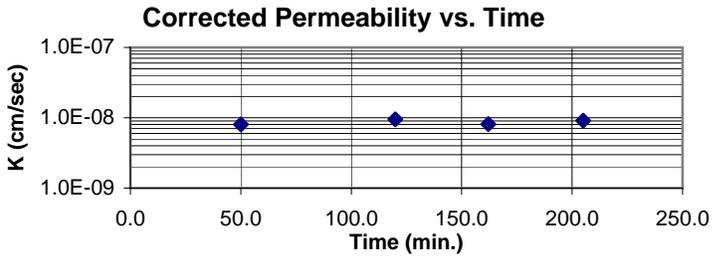
Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter ASTM D 5084-03

Project Name AEP-Clifty Creek-West Bottom Ash and Fly Ash Ponds subsurface exploration Project No. 175539022
 Source B-2, 42.5'-44.5', T1 42.6'-43.1' Test ID 48A
 Visual Classification Lean Clay (CL), gray, wet, soft Prepared By CSM
 Undisturbed XX Specific Gravity 2.69 ASTM D854-A Date 11-30-09
 Maximum Dry Density (pcf) _____ Percent of Maximum _____
 Permeant: De-aired tap water
 Selection and Preparation Comments: _____

Specimens (if compacted) were compacted in a Proctor Mold as follows: The Maximum Dry Density was converted to Wet Density, this mass was divided by 4 (layers) and 3 of the 4 layers were compacted into the mold using a Proctor Hammer using 19 blows per layer. The density was varied by reducing the height of the drop by the amount listed beside "Compacted". The specimen was trimmed from the bottom two layers.

	Initial Specimen Data	After Consolidation Data	After Test Data	Final Pressures (psi)
Height (in.)	1.4906	1.3473	1.3472	Chamber <u>75</u>
Diameter (in.)	2.8023		2.8480	Influent <u>70</u>
Moisture Content (%)	31.6		26.0	Effluent <u>65</u>
Dry Unit Weight (pcf)	91.6		98.1	Applied Head Difference (psi) <u>5</u>
Void Ratio	0.834		0.712	Back Pressure Saturated to (psi) <u>65</u>
Degree of Saturation (%)	101.8		98.1	Maximum Effective Consolidation Stress (psi) <u>10</u>
Trimmings MC (%)	30.9			Minimum Effective Consolidation Stress (psi) <u>5</u>

Date	Clock (24H:M)	Temp. °F	Bottom Head	Top Head	Test Time (sec)	Hydraulic Conductivity			
						k (m/s)	k (cm/s)	k @ 20° C (m/s)	k @ 20° C (cm/s)
12-22-09	8:20	70.0	22.26	3.46	0	---	---	---	---
12-22-09	9:10	70.0	22.13	3.59	3.00E+03	8.3E-11	8.3E-09	8.1E-11	8.1E-09
12-22-09	10:20	70.0	21.92	3.81	4.20E+03	9.8E-11	9.8E-09	9.5E-11	9.5E-09
12-22-09	11:02	70.0	21.81	3.92	2.52E+03	8.4E-11	8.4E-09	8.1E-11	8.1E-09
12-22-09	11:45	70.0	21.68	4.04	2.58E+03	9.3E-11	9.3E-09	9.1E-11	9.1E-09



A gradient of approximately 92.6 was used for this test. This gradient exceeds ASTM guidelines for maximum gradient, but was used to achieve the requestors desired test duration. Examination of the sample shows no signs of material loss or clogging that may affect test results.

Average Hydraulic Conductivity @ 20° C (last 4 determinations) m/s 8.70E-11 cm/s 8.70E-09
 Average Hydraulic Conductivity @ 20° C (last run) m/s 8.70E-11 cm/s 8.70E-09

Reviewed by: _____



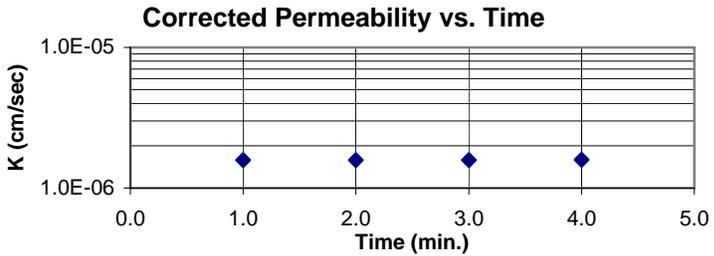
Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter ASTM D 5084-03

Project Name AEP-Clifty Creek- West Bottom Ash and Fly Ash Ponds subsurface exploration Project No. 175539022
 Source B-4, 7.5'-9.5', TI 7.6'-8.1' Test ID 82A
 Visual Classification Lean Clay (CL), brown, moist, firm, organic odor Prepared By CSM
 Undisturbed XX Specific Gravity 2.7 ASTM D854-A Date 12-9-09
 Maximum Dry Density (pcf) _____ Percent of Maximum _____
 Permeant: De-aired tap water
 Selection and Preparation Comments: _____

Specimens (if compacted) were compacted in a Proctor Mold as follows: The Maximum Dry Density was converted to Wet Density, this mass was divided by 4 (layers) and 3 of the 4 layers were compacted into the mold using a Proctor Hammer using 19 blows per layer. The density was varied by reducing the height of the drop by the amount listed beside "Compacted". The specimen was trimmed from the bottom two layers.

	Initial Specimen Data	After Consolidation Data	After Test Data	Final Pressures (psi)
Height (in.)	1.4754	1.4631	1.4654	Chamber <u>75</u>
Diameter (in.)	2.8057		2.8200	Influent <u>70</u>
Moisture Content (%)	18.8		20.1	Effluent <u>65</u>
Dry Unit Weight (pcf)	110.0		109.6	Applied Head Difference (psi) <u>5</u>
Void Ratio	0.532		0.537	Back Pressure Saturated to (psi) <u>65</u>
Degree of Saturation (%)	95.6		100.8	Maximum Effective Consolidation Stress (psi) <u>10</u>
Trimmings MC (%)	19.1			Minimum Effective Consolidation Stress (psi) <u>5</u>

Date	Clock (24H:M)	Temp. °F	Bottom Head	Top Head	Test Time (sec)	Hydraulic Conductivity			
						k (m/s)	k (cm/s)	k @ 20° C (m/s)	k @ 20° C (cm/s)
12-21-09	11:25	73.0	15.06	10.34	0	---	---	---	---
12-21-09	11:26	73.0	14.94	10.46	6.00E+01	1.7E-08	1.7E-06	1.6E-08	1.6E-06
12-21-09	11:27	73.0	14.82	10.58	6.00E+01	1.7E-08	1.7E-06	1.6E-08	1.6E-06
12-21-09	11:28	73.0	14.70	10.70	6.00E+01	1.7E-08	1.7E-06	1.6E-08	1.6E-06
12-21-09	11:29	73.0	14.58	10.82	6.00E+01	1.7E-08	1.7E-06	1.6E-08	1.6E-06



A gradient of approximately 93.5 was used for this test. This gradient exceeds ASTM guidelines for maximum gradient, but was used to achieve the requestors desired test duration. Examination of the sample shows no signs of material loss or clogging that may affect test results.

Average Hydraulic Conductivity @ 20° C (last 4 determinations) m/s 1.58E-08 cm/s 1.58E-06
 Average Hydraulic Conductivity @ 20° C (last run) m/s 1.58E-08 cm/s 1.58E-06

Reviewed by: _____



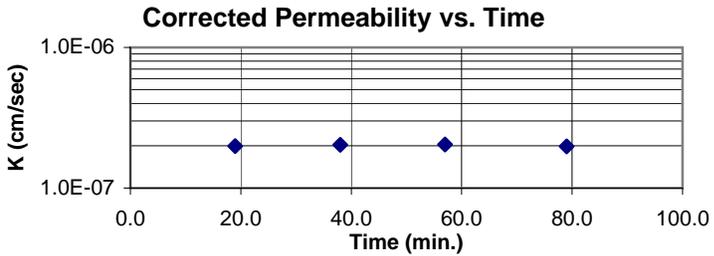
Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter ASTM D 5084-03

Project Name AEP-Clifty Creek-West Bottom Ash and Fly Ash Ponds subsurface exploration Project No. 175539022
 Source B-6, 17.5'-19.0', T1 17.6'-18.1' Test ID 291
 Visual Classification Lean Clay (CL), brown, moist, firm Prepared By CSM
 Undisturbed XX Specific Gravity 2.68 ASTM D854-A Date 12-9-09
 Maximum Dry Density (pcf) _____ Percent of Maximum _____
 Permeant: De-aired tap water
 Selection and Preparation Comments: _____

Specimens (if compacted) were compacted in a Proctor Mold as follows: The Maximum Dry Density was converted to Wet Density, this mass was divided by 4 (layers) and 3 of the 4 layers were compacted into the mold using a Proctor Hammer using 19 blows per layer. The density was varied by reducing the height of the drop by the amount listed beside "Compacted". The specimen was trimmed from the bottom two layers.

	Initial Specimen Data	After Consolidation Data	After Test Data	Final Pressures (psi)	
Height (in.)	1.4778	1.4443	1.4478	Chamber	75
Diameter (in.)	2.8030		2.7955	Influent	70
Moisture Content (%)	32.0		33.2	Effluent	65
Dry Unit Weight (pcf)	87.1		89.4	Applied Head Difference (psi)	5
Void Ratio	0.921		0.872	Back Pressure Saturated to (psi)	65
Degree of Saturation (%)	93.1		102.1	Maximum Effective Consolidation Stress (psi)	10
Trimmings MC (%)	33.1			Minimum Effective Consolidation Stress (psi)	5

Date	Clock (24H:M)	Temp. °F	Bottom Head	Top Head	Test Time (sec)	Hydraulic Conductivity			
						k (m/s)	k (cm/s)	k @ 20° C (m/s)	k @ 20° C (cm/s)
12-21-09	13:10	73.0	19.94	4.28	0	---	---	---	---
12-21-09	13:29	73.0	19.65	4.56	1.14E+03	2.1E-09	2.1E-07	2.0E-09	2.0E-07
12-21-09	13:48	73.0	19.36	4.85	1.14E+03	2.2E-09	2.2E-07	2.0E-09	2.0E-07
12-21-09	14:07	73.0	19.07	5.14	1.14E+03	2.2E-09	2.2E-07	2.0E-09	2.0E-07
12-21-09	14:29	73.0	18.71	5.43	1.32E+03	2.1E-09	2.1E-07	2.0E-09	2.0E-07



A gradient of approximately 93.4 was used for this test. This gradient exceeds ASTM guidelines for maximum gradient, but was used to achieve the requestors desired test duration. Examination of the sample shows no signs of material loss or clogging that may affect test results.

Average Hydraulic Conductivity @ 20° C (last 4 determinations) m/s 2.01E-09 cm/s 2.01E-07
 Average Hydraulic Conductivity @ 20° C (last run) m/s 2.01E-09 cm/s 2.01E-07

Reviewed by: _____

LANDFILL RUNOFF COLLECTION POND

PERMEABILITY TEST (ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

Project Number GTX-1516 Tested By JM
 Project Name Clifty Creek Test Date 12/12/10
 Boring No. B-7 Reviewed By MM
 Sample No. --- Review Date 12/15/10
 Sample Depth 27.4-27.7 ft Lab No. 5
 Sample Description Lean clay



Sample Data

Length, in		Diameter, in		Pan No.	CS-1
Location 1	2.831	Location 1	2.825	Dry Soil+Pan, grams	484.22
Location 2	2.830	Location 2	2.825	Pan Weight, grams	8.17
Location 3	2.829	Location 3	2.825		
Average	2.830	Average	2.825	Moisture Content, %	24.6
		Wet Soil + Tare, grams	593.33	Wet Unit Weight, pcf	127.4
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	102.2

Remarks: _____

Chamber Pressure, psi 65
 Back Pressure, psi 60
 Confining Pressure, psi 5

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H _a (cm)	H ₁ (cm)	H _b (cm)	H ₂ (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				2820	9.9	100.3	10.60	99.5	8.4E-08	22	8.1E-08
				6300	9.9	100.3	11.80	98.4	9.7E-08	24	8.8E-08
				9000	9.9	100.3	12.50	97.7	9.4E-08	24	8.5E-08
				14400	9.9	100.3	14.00	96.1	9.5E-08	24	8.6E-08
				27000	9.9	100.3	17.00	93	9.1E-08	24	8.3E-08

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	102.2	N/A	Vertical

Avg. k at 20 °C 8.4E-08 cm/sec

a = area of burette in cm² H_a = initial inlet head in cm H_b = final inlet head in cm a = 0.16 cm²
 L = length of sample in cm H₁ = initial outlet head in cm H₂ = final outlet head in cm A = 40.44 cm²
 A = area of sample in cm² t = time in seconds L = 7.19 cm



HYDRAULIC CONDUCTIVITY

Project No. **GTX-1516** Tested By **JM**
Project Name **Clifty Creek** Test Date **12/12/2010**
Boring No. **B-7** Reviewed By **MM**
Sample No. **---** Review Date **12/15/2010**
Sample Depth **27.4-27.7 ft** Lab No. **5**
Sample Description **Lean clay**

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	<i>UD</i>
Sample Orientation:	<i>Vertical</i>
Initial Water Content, %:	<i>24.6</i>
Wet Unit Weight, pcf:	<i>127.4</i>
Dry Unit Weight, pcf:	<i>102.2</i>
Compaction, %:	<i>N/A</i>
Hydraulic Conductivity, cm/sec. @20 °C	<i>8.4E-08</i>

Remarks: _____

PERMEABILITY TEST (ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

Project Number GTX-1516 Tested By JM
 Project Name Clifty Creek Test Date 12/12/10
 Boring No. B-8 Reviewed By MM
 Sample No. --- Review Date 12/15/10
 Sample Depth 29.7-30.3 ft Lab No. 7
 Sample Description Lean clay with sand



Sample Data

Length, in		Diameter, in		Pan No.	A44
Location 1	2.841	Location 1	2.775	Dry Soil+Pan, grams	487.70
Location 2	2.843	Location 2	2.784	Pan Weight, grams	8.99
Location 3	2.844	Location 3	2.788		
Average	2.843	Average	2.782	Moisture Content, %	23.5
		Wet Soil + Tare, grams	591.11	Wet Unit Weight, pcf	130.3
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	105.5

Remarks: _____

Chamber Pressure, psi 65
 Back Pressure, psi 60
 Confining Pressure, psi 5

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H _a (cm)	H ₁ (cm)	H _b (cm)	H ₂ (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				3200	6.5	107.2	6.90	106.9	3.2E-08	22	3.1E-08
				6600	6.5	107.2	7.40	106.4	3.8E-08	24	3.4E-08
				11400	6.5	107.2	8.10	105.7	4.0E-08	24	3.7E-08
				18000	6.5	107.2	9.00	104.8	4.1E-08	24	3.7E-08
				30000	6.5	107.2	10.20	103.6	3.7E-08	24	3.3E-08

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	105.5	N/A	Vertical

Avg. k at 20 °C 3.4E-08 cm/sec

a = area of burette in cm² H_a = initial inlet head in cm H_b = final inlet head in cm a = 0.16 cm²
 L = length of sample in cm H₁ = initial outlet head in cm H₂ = final outlet head in cm A = 39.23 cm²
 A = area of sample in cm² t = time in seconds L = 7.22 cm



HYDRAULIC CONDUCTIVITY

Project No. **GTX-1516** Tested By **JM**
Project Name **Clifty Creek** Test Date **12/12/2010**
Boring No. **B-8** Reviewed By **MM**
Sample No. **---** Review Date **12/15/2010**
Sample Depth **29.7-30.3 ft** Lab No. **7**
Sample Description **Lean clay with sand**

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	<i>UD</i>
Sample Orientation:	<i>Vertical</i>
Initial Water Content, %:	<i>23.5</i>
Wet Unit Weight, pcf:	<i>130.3</i>
Dry Unit Weight, pcf:	<i>105.5</i>
Compaction, %:	<i>N/A</i>
Hydraulic Conductivity, cm/sec. @20 °C	<i>3.4E-08</i>

Remarks: _____

PERMEABILITY TEST (ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

Project Number GTX-1516 Tested By JM
 Project Name Clifty Creek Test Date 12/12/10
 Boring No. B-9 Reviewed By MM
 Sample No. --- Review Date 12/15/10
 Sample Depth 18.3-18.6 Lab No. 8
 Sample Description Lean clay



Sample Data

Length, in		Diameter, in		Pan No.	a-18
Location 1	2.899	Location 1	2.872	Dry Soil+Pan, grams	541.33
Location 2	2.901	Location 2	2.877	Pan Weight, grams	9.11
Location 3	2.905	Location 3	2.877		
Average	2.902	Average	2.875	Moisture Content, %	21.0
		Wet Soil + Tare, grams	644.22	Wet Unit Weight, pcf	130.3
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	107.6

Remarks: _____

Chamber Pressure, psi 65
 Back Pressure, psi 60
 Confining Pressure, psi 5

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H _a (cm)	H ₁ (cm)	H _b (cm)	H ₂ (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				1800	5.3	100.4	5.70	100	6.6E-08	22	6.3E-08
				4800	5.3	100.4	6.40	99.3	6.9E-08	24	6.2E-08
				8400	5.3	100.4	7.20	98.5	6.8E-08	24	6.2E-08
				16200	5.3	100.4	8.80	96.9	6.6E-08	24	6.0E-08
				27000	5.3	100.4	11.00	94.7	6.7E-08	24	6.0E-08

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	107.6	N/A	Vertical

Avg. k at 20 °C 6.2E-08 cm/sec

a = area of burette in cm² H_a = initial inlet head in cm H_b = final inlet head in cm a = 0.16 cm²
 L = length of sample in cm H₁ = initial outlet head in cm H₂ = final outlet head in cm A = 41.89 cm²
 A = area of sample in cm² t = time in seconds L = 7.37 cm



HYDRAULIC CONDUCTIVITY

Project No. **GTX-1516** Tested By **JM**
Project Name **Clifty Creek** Test Date **12/12/2010**
Boring No. **B-9** Reviewed By **MM**
Sample No. **---** Review Date **12/15/2010**
Sample Depth **18.3-18.6** Lab No. **8**
Sample Description **Lean clay**

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	<i>UD</i>
Sample Orientation:	<i>Vertical</i>
Initial Water Content, %:	<i>21.0</i>
Wet Unit Weight, pcf:	<i>130.3</i>
Dry Unit Weight, pcf:	<i>107.6</i>
Compaction, %:	<i>N/A</i>
Hydraulic Conductivity, cm/sec. @20 °C	<i>6.2E-08</i>

Remarks: _____

PERMEABILITY TEST (ASTM D5084 - 90) (Method C, Increasing Tailwater Level)

Project Number GTX-1516 Tested By JM
 Project Name Clifty Creek Test Date 12/12/10
 Boring No. B-10 Reviewed By MM
 Sample No. --- Review Date 12/15/10
 Sample Depth 16.4-16.7 ft Lab No. 11
 Sample Description Lean clay



Sample Data

Length, in		Diameter, in		Pan No.	a-22
Location 1	3.121	Location 1	2.876	Dry Soil+Pan, grams	539.99
Location 2	3.203	Location 2	2.877	Pan Weight, grams	9.13
Location 3	3.126	Location 3	2.877		
Average	3.150	Average	2.877	Moisture Content, %	21.1
		Wet Soil + Tare, grams	642.99	Wet Unit Weight, pcf	119.6
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	98.8

Remarks: _____

Chamber Pressure, psi 65
 Back Pressure, psi 60
 Confining Pressure, psi 5

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	H _a (cm)	H ₁ (cm)	H _b (cm)	H ₂ (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				1800	7.7	99.3	8.50	98.5	1.5E-07	22	1.4E-07
				4800	7.7	99.3	9.90	97.1	1.6E-07	22	1.5E-07
				8400	7.7	99.3	11.20	94.7	1.7E-07	22	1.6E-07
				16200	7.7	99.3	13.00	92.9	1.3E-07	22	1.2E-07
				24000	7.7	99.3	15.00	90.9	1.2E-07	22	1.1E-07

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	UD	107.6	N/A	Vertical

Avg. k at 20 °C 1.4E-07 cm/sec

a = area of burette in cm² H_a = initial inlet head in cm H_b = final inlet head in cm a = 0.16 cm²
 L = length of sample in cm H₁ = initial outlet head in cm H₂ = final outlet head in cm A = 41.93 cm²
 A = area of sample in cm² t = time in seconds L = 8.00 cm



HYDRAULIC CONDUCTIVITY

Project No. **GTX-1516** Tested By **JM**
Project Name **Clifty Creek** Test Date **12/12/2010**
Boring No. **B-10** Reviewed By **MM**
Sample No. **---** Review Date **12/15/2010**
Sample Depth **16.4-16.7 ft** Lab No. **11**
Sample Description **Lean clay**

ASTM D5084 - Falling Head (Method C RisingTail)

Sample Type:	<i>UD</i>
Sample Orientation:	<i>Vertical</i>
Initial Water Content, %:	<i>21.1</i>
Wet Unit Weight, pcf:	<i>119.6</i>
Dry Unit Weight, pcf:	<i>98.8</i>
Compaction, %:	<i>N/A</i>
Hydraulic Conductivity, cm/sec. @20 °C	<i>1.4E-07</i>

Remarks: _____

APPENDIX G

STANDARD PROCTOR MOISTURE-DENSITY TESTS

BOILER SLAG POND DAM

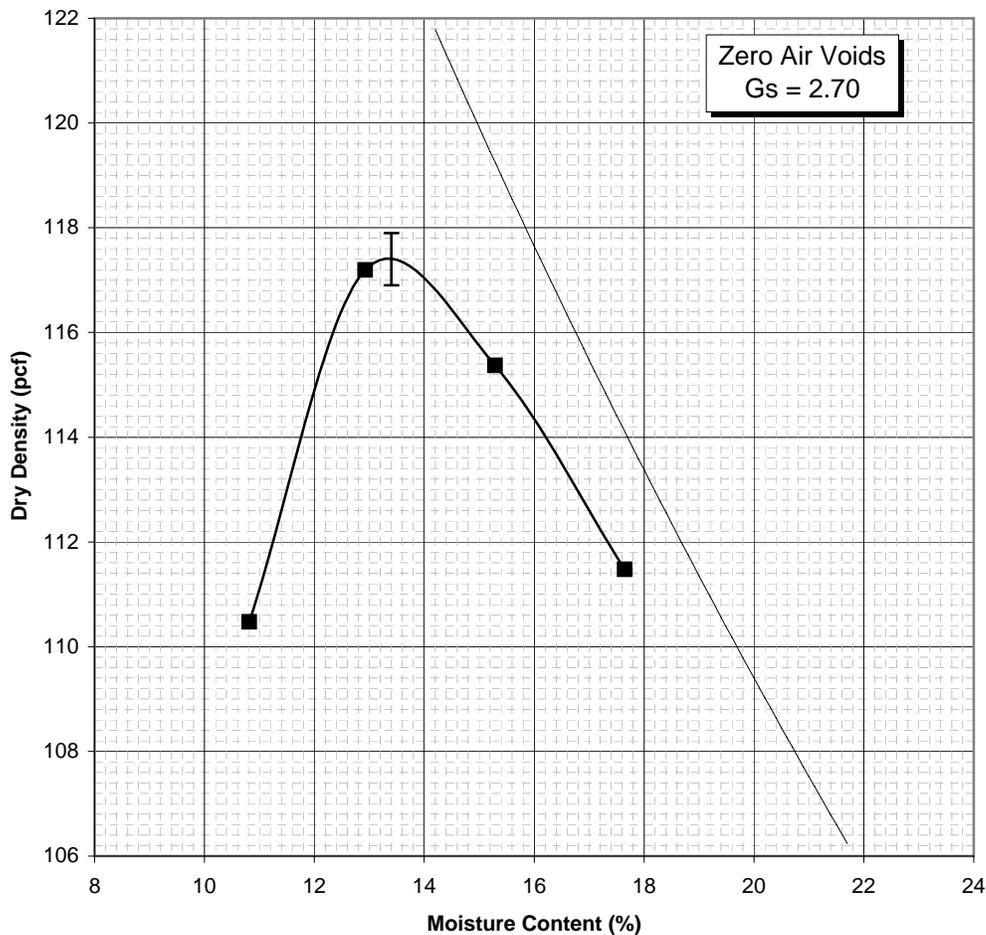


Moisture-Density Data Sheet

Project: AEP - Clifty Creek - West Bottom Ash Pond
 Source: B-1, 5.0'
 Sample Description: Brown lean clay with gravel, moist
 Visual Notes: N/A
 Prepared: Dry Oversized Fraction: < 5 % Rammer: Mechanical

Project No.: 175539022
 Sample No.: 319
 Nmc: 15.6 %
 Test Method: ASTM D 698 - Method A
 Gs - Fines: Assumed

Mold Weight 2041 grams		Moisture Determination				
Wet Weight plus Mold (grams)	Wet Weight minus Mold (grams)	Wet Soil and Can Weight (grams)	Dry Soil and Can Weight (grams)	Can Weight (grams)	Water Content (%)	Dry Density (pcf)
3879	1838	432.75	397.39	70.52	10.8	110.5
4028	1987	462.87	418.39	74.30	12.9	117.2
4038	1997	405.73	362.08	76.62	15.3	115.4
4010	1969	368.39	324.37	74.94	17.6	111.5



Maximum Dry Density 117.4 PCF
Optimum Moisture Content 13.4 %



Moisture-Density Data Sheet

Project: AEP - Clifty Creek - West Bottom Ash Pond

Project No.: 175539022

Source: B-5, 7.5'

Sample No.: 320

Sample Description: brown lean clay, moist

Nmc: 18.2 %

Visual Notes: N/A

Test Method: ASTM D 698 - Method A

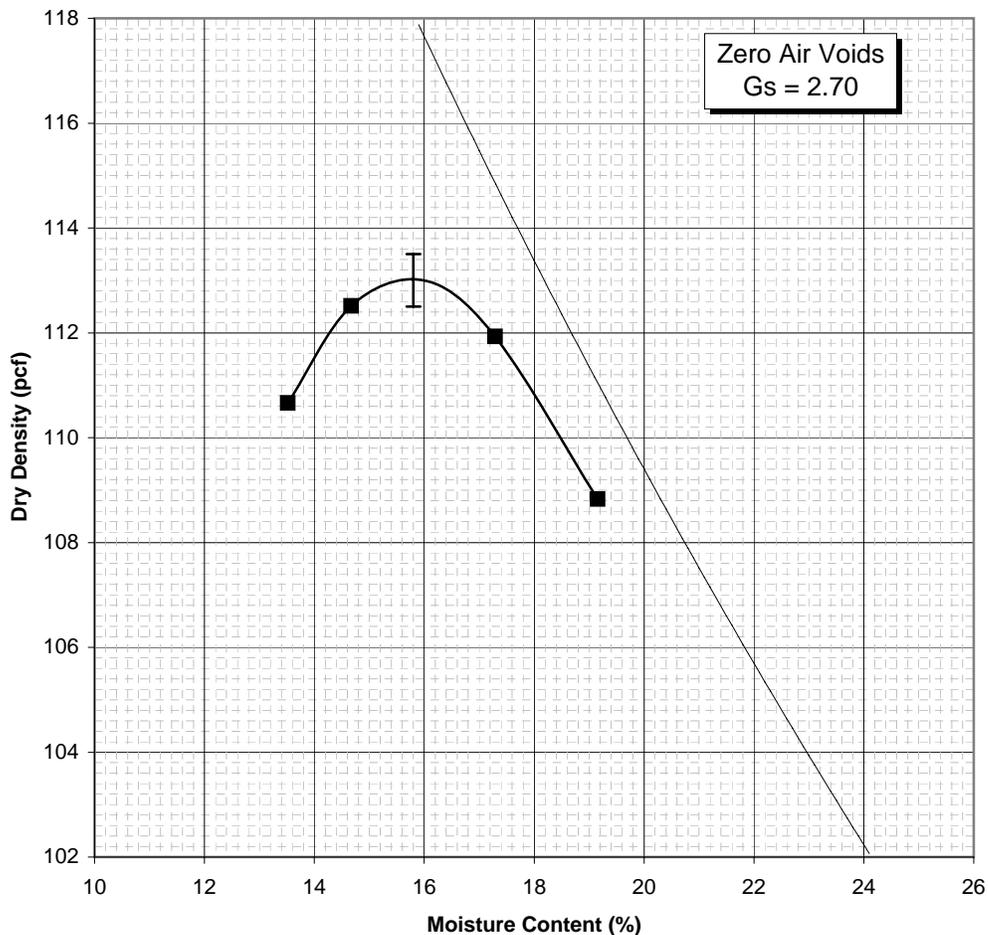
Prepared: Dry

Oversized Fraction: < 5 %

Rammer: Mechanical

Gs - Fines: Assumed

Mold Weight 2041 grams		Moisture Determination				
Wet Weight plus Mold (grams)	Wet Weight minus Mold (grams)	Wet Soil and Can Weight (grams)	Dry Soil and Can Weight (grams)	Can Weight (grams)	Water Content (%)	Dry Density (pcf)
3927	1886	422.84	381.18	72.94	13.5	110.7
3978	1937	388.97	348.78	74.79	14.7	112.5
4012	1971	392.34	345.43	74.11	17.3	111.9
3988	1947	409.73	355.79	74.24	19.2	108.8



Maximum Dry Density 113.0 PCF
Optimum Moisture Content 15.8 %

LANDFILL RUNOFF COLLECTION POND



Moisture-Density Data Sheet

Project: AEP - Clifty Creek - South Fly Ash Pond

Project No.: 175539022

Source: B-7, 7.0'

Sample No.: 321

Sample Description: brown lean clay, moist

Nmc: 20.5 %

Visual Notes: N/A

Test Method: ASTM D 698 - Method A

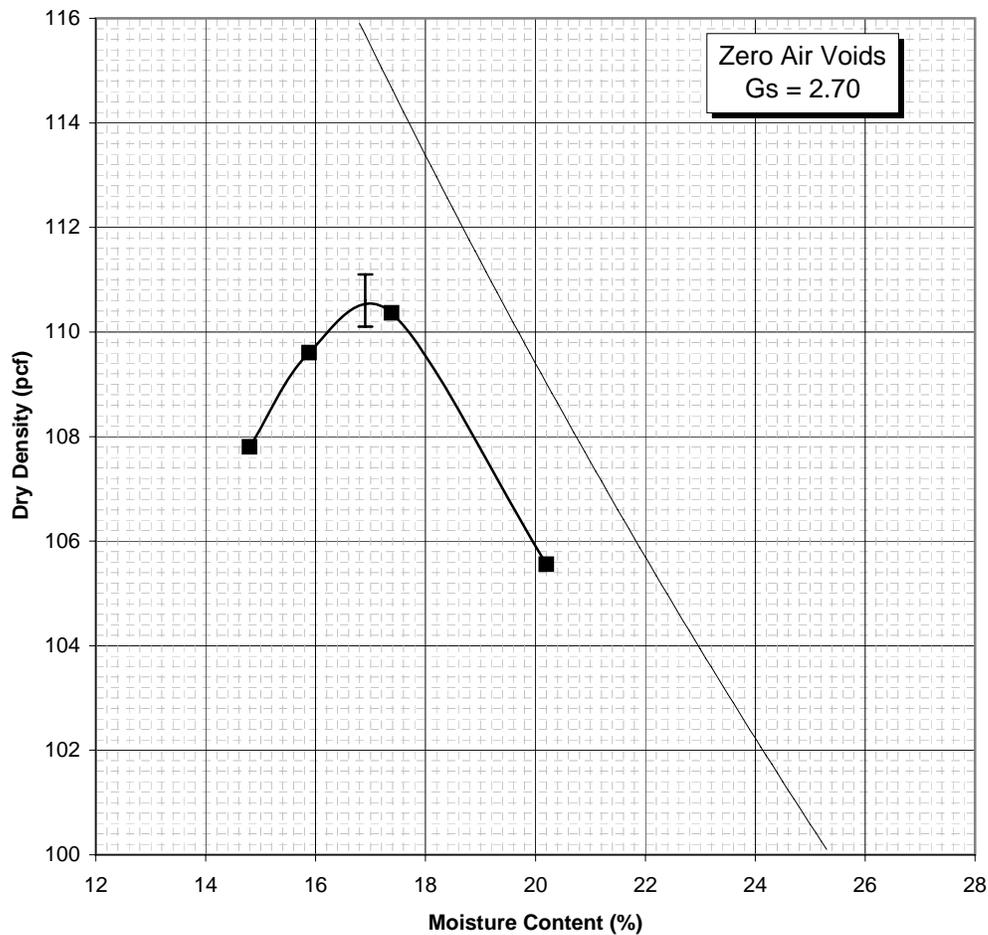
Prepared: Dry

Oversized Fraction: < 5 %

Rammer: Mechanical

Gs - Fines: Assumed

Mold Weight 2041 grams		Moisture Determination				
Wet Weight plus Mold (grams)	Wet Weight minus Mold (grams)	Wet Soil and Can Weight (grams)	Dry Soil and Can Weight (grams)	Can Weight (grams)	Water Content (%)	Dry Density (pcf)
3899	1858	421.72	374.30	53.84	14.8	107.8
3948	1907	420.48	370.25	54.04	15.9	109.6
3986	1945	425.03	373.25	75.37	17.4	110.4
3946	1905	465.82	400.33	76.15	20.2	105.6



Maximum Dry Density 110.6 PCF
Optimum Moisture Content 16.9 %

APPENDIX H

LIQUEFACTION ANALYSIS

BOILER SLAG POND DAM: 2015 CCR MANDATE

FINE-GRAINED ANALYSIS

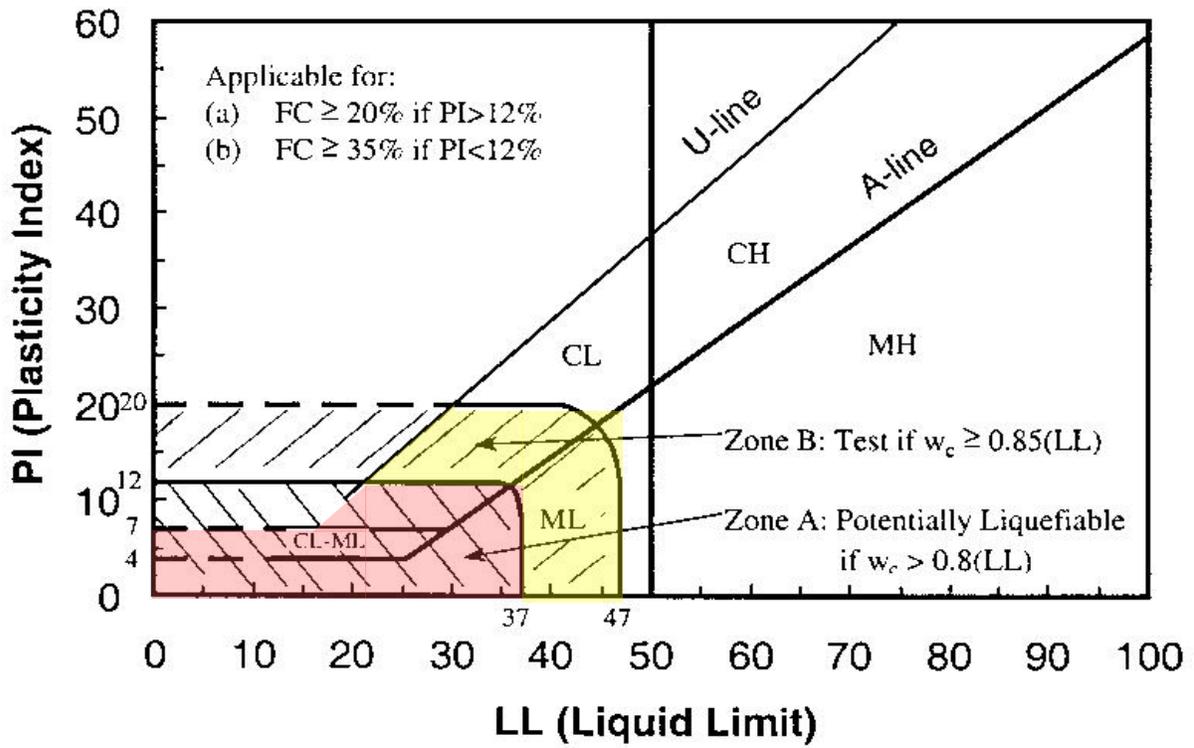
Liquefaction Susceptibility of Fine-Grained Soils

Stantec Project Number:	175553022
Project Name:	AEP Clifty Creek
Site/Structure Name:	West Bottom Ash Dam

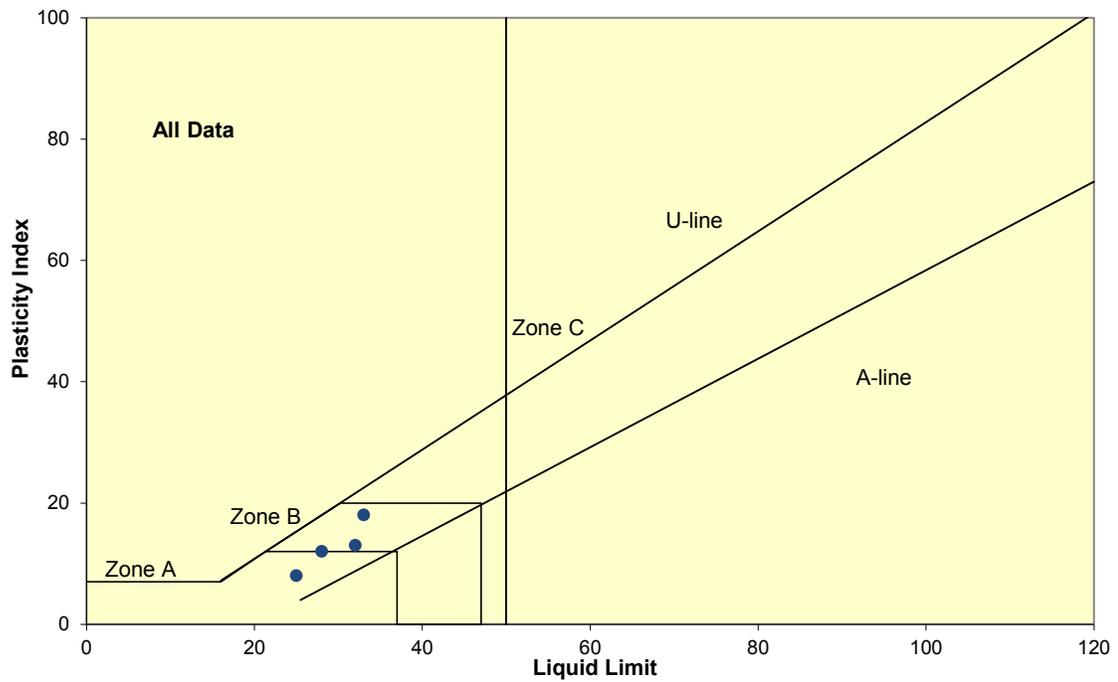
Note: NP = Non-Plastic

Lab ID	Boring	Depth(s)	Soil Classification	NMC (w _c) (%)	% Passing #200	% Passing #40	LL	PI
4	B-1	10.0-11.5, 12.5-14.0	CL	19.1	84	98.4	32	13
20	B-1	47.5-49.0, 50.0-51.5	CL	25.3	84.1	99.7	28	12
43	B-2	32.5-34.0, 35.0-36.5	CL	32.1	79.7	98.7	33	18
87	B-4	20.0-21.5, 22.5-24.0	CL	26.6	80.7	99.7	25	8
103	B-4	57.5-59.0, 60.0-61.5	GW-GM	10.9	5.7	13.6	NP	NP
129	B-5	55.0-56.5, 57.5-59.0	ML	24.9	54	99.9	NP	NP

Sand-like versus Clay-like Behavior (-1 indicates result does not meet criteria, green shading indicates result does meet criteria, no results shown for non-plastic material)												Overall Judgement based on 3 methods (sand-like or clay-like)
Using Criteria published by Seed et al (2003)						Using Criteria published by Idriss and Boulanger (2008)		Using criteria published by MSHA (2010)				
Meets criteria for sand-like behavior		Meets criteria for clay-like behavior				Meets criteria for sand-like behavior	Meets criteria for clay-like behavior	Meets criteria for sand-like behavior	Meets criteria for clay-like behavior	Borderline soils (treat as sand-like)		
LL in Zone A (see plot)	PI in Zone A (see plot)	LL in Zone B (see plot)	PI in Zone B (see plot)	LL in Zone C (see plot)	PI in Zone C (see plot)	PI < 7	PI >= 7	PI <= 7	P40>=35%, P200>=20%, and PI>=10	7 < PI < 10, or does not meet P40 or P200		
-1	-1	32	13	-1	-1	-1	13	-1	13	-1	Clay-like	
28	12	-1	-1	-1	-1	-1	12	-1	12	-1	Clay-like	
-1	-1	33	18	-1	-1	-1	18	-1	18	-1	Clay-like	
25	8	-1	-1	-1	-1	-1	8	-1	-1	8	Sand-like	
											Sand-like	
											Sand-like	

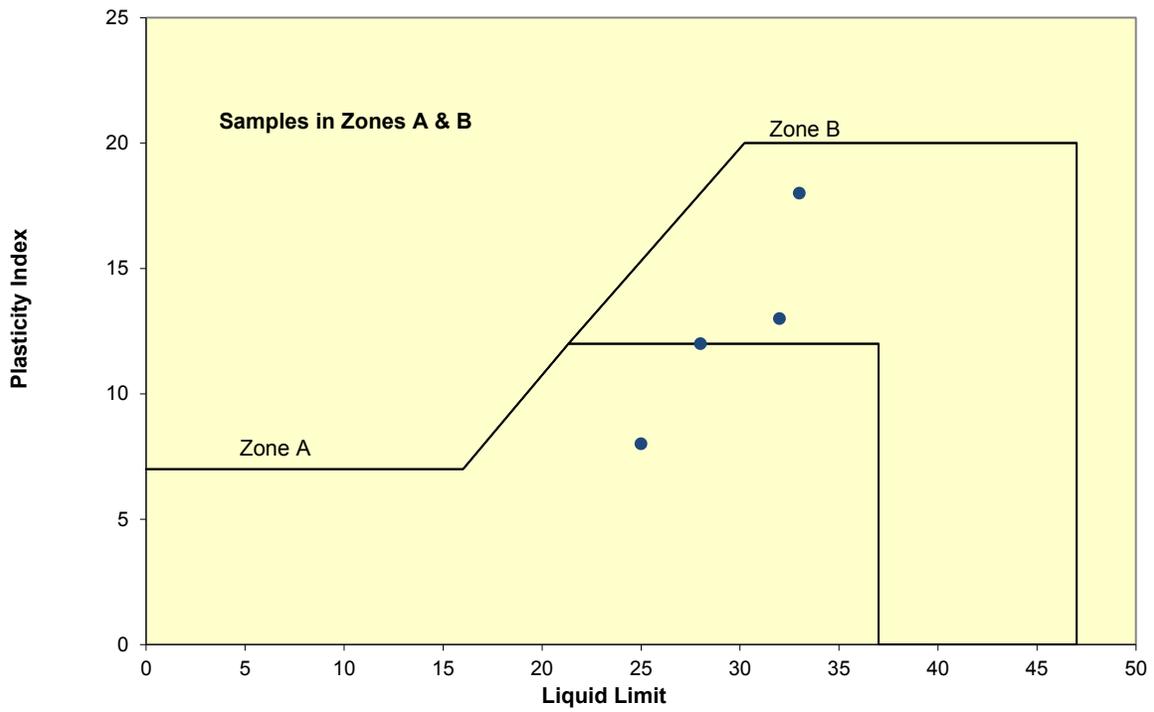


(a)

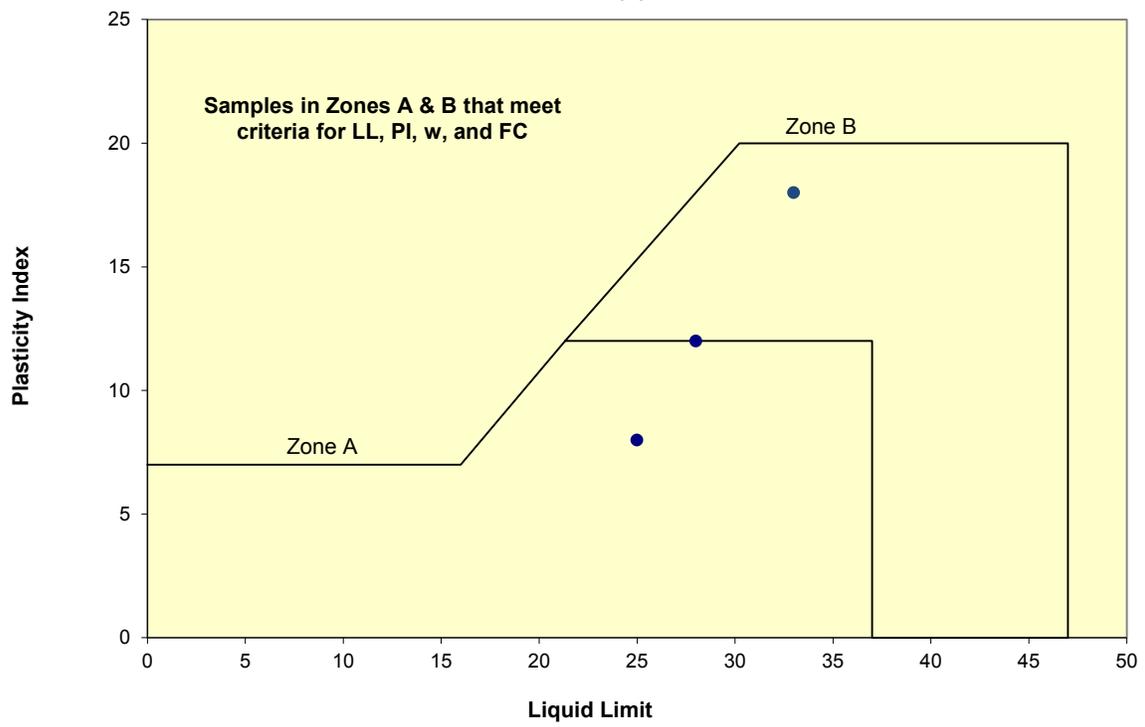


(b)

Screening Criteria for Liquefiable Fine-Grained Soils (Seed et al. 2003)

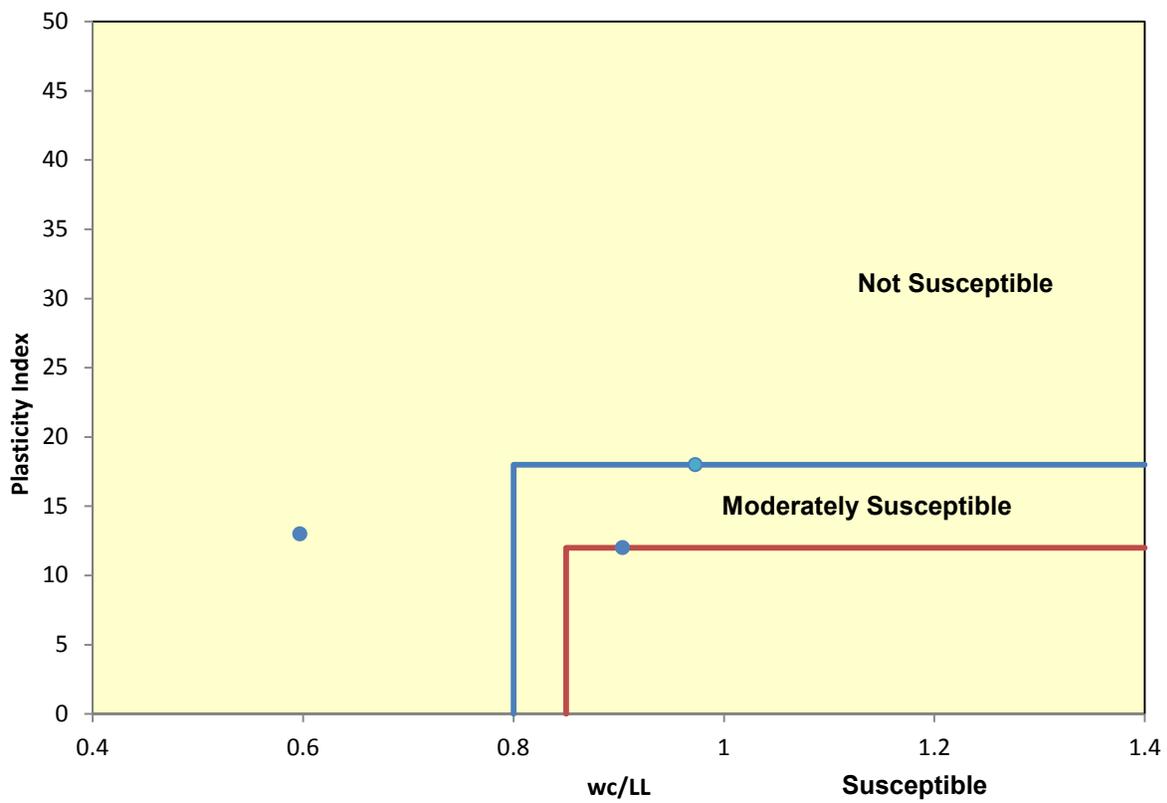
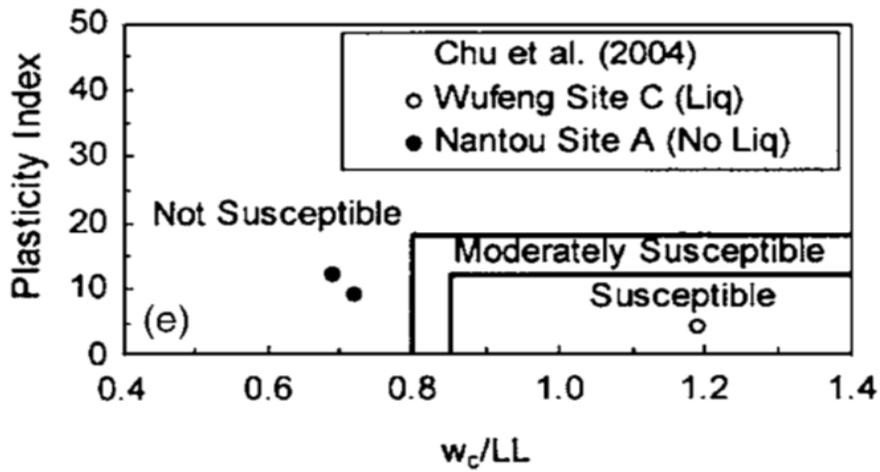


(c)



(d)

Screening Criteria for Liquefiable Fine-Grained Soils (Seed et al. 2003)

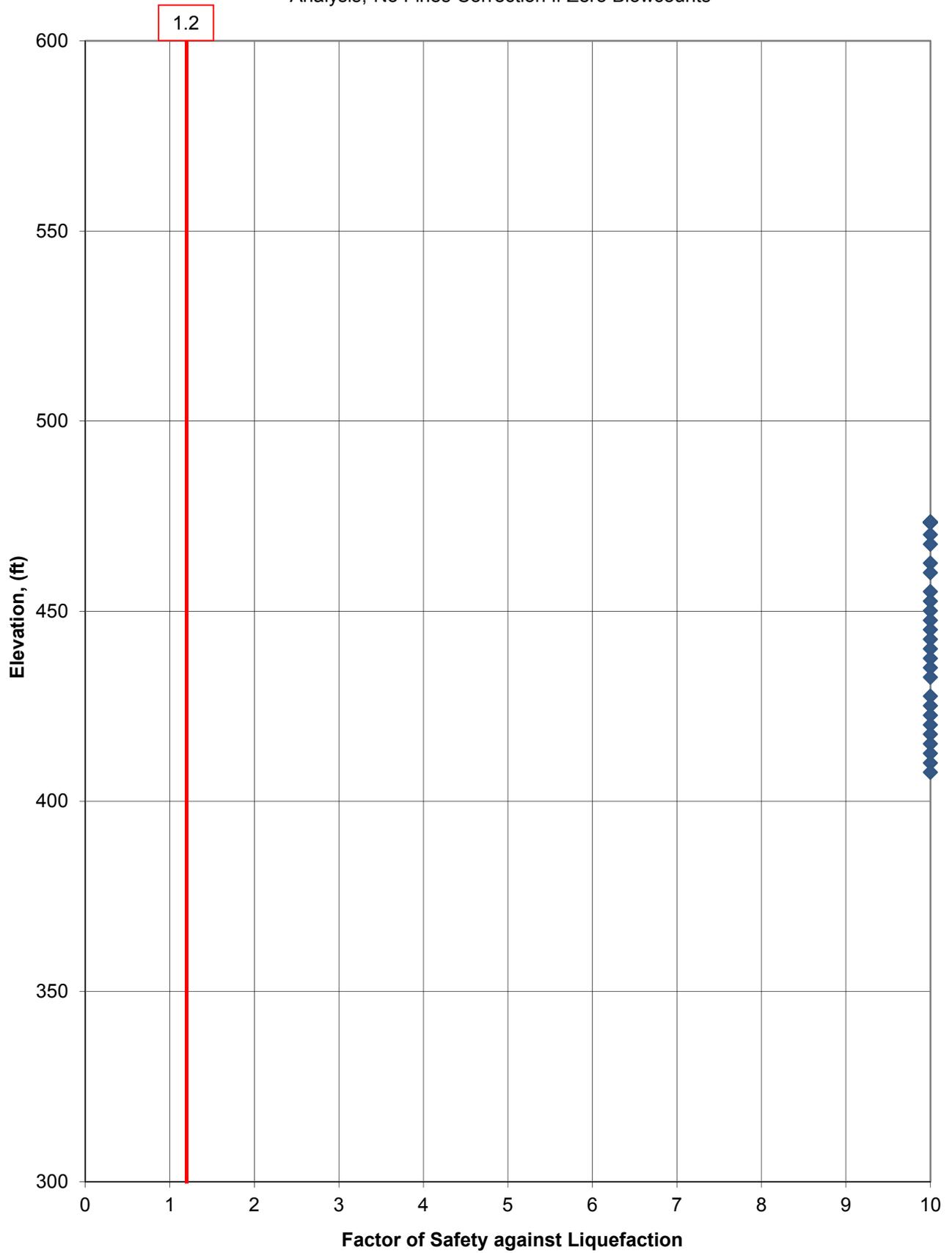


Screening Criteria for Assessing Liquefaction in Fine Grained Soils (Bray and Sancio 2006)

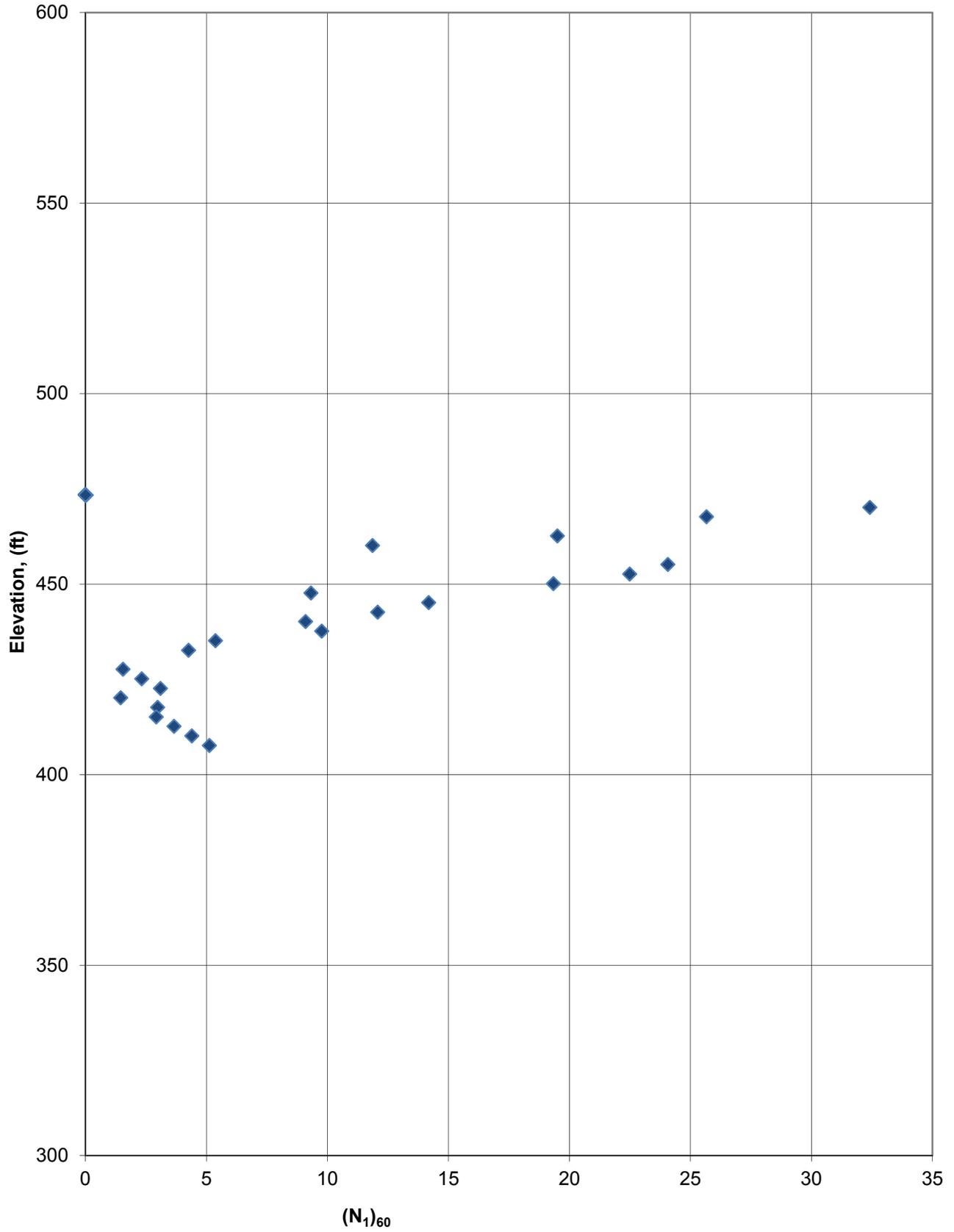
COARSE-GRAINED ANALYSIS

Depth of Mid. Pt. of Sample (ft.)	Vert. Total Stress during EQ (tsf)	Vert. Total Stress during EQ w/ Fill (tsf)	Static Pore Pressure during EQ (tsf)	Vert. Eff. Stress during EQ (tsf)	Vert. Eff. Stress during EQ w/ Fill (tsf)	Alpha I	Beta I	(N) _{60cs}	CRR7.5	Ksigma	Kalpha	EQ Source		Event (MCE, OBE, etc.)	Shake Stress Curve Fit Parameters							
												a max (g)	EQ Mag (Mw)		m4:	m3:	m2:	m1:				
z	σ_v	$\sigma_{v,with\ fill}$	u	σ'_v	$\sigma'_{v,with\ fill}$							Mag. Scaling	CRR	EQ Motion File	Using SHAKE Data	Simplified						
												Factor (Cm)	Design EQ	Stress Reduction	Simplified Stress Reduction	Max. Shake Stress (psf)	Avg. Shake Stress (psf)	CSR eq	FS liq	FS liq	FS liq	FS liq
														Design EQ	Design EQ	Design EQ	Design EQ	Design EQ	Design EQ	for plot	Design EQ	for plot
Boring ID: B-1 Top of Fill Elevation: 473.4 Fill Height: 0.0 Fill Total Unit Weight: 125 Fill Total Stress: 0.00						<i>Note: A factor of safety shown as "NA" implies that the soil type is not appropriately evaluated using this methodology. This applies to soils classified as CL, CH, CL-ML and MH. These soils should be evaluated using methods for fine-grained soils. Also, "NA" implies that coarse grained soils with equivalent clean sand N-values greater than 30 are resistant to liquefaction.</i>																
	totstr-top		u-top	effstr-top																		
	0.16		0.00	0.16																		
3.3	0.20	0.20	0.00	0.20	0.20	NA	NA	NA	NA	NA	NA	0.95	NA	0.994	0.055	0	0	0.000	NA	10.0	NA	10.00
5.8	0.36	0.36	0.00	0.36	0.36	NA	NA	NA	NA	NA	NA	0.95	NA	0.989	0.055	0	0	0.000	NA	10.0	NA	10.00
10.8	0.67	0.67	0.00	0.67	0.67	NA	NA	NA	NA	NA	NA	0.95	NA	0.978	0.054	0	0	0.000	NA	10.0	NA	10.00
13.3	0.83	0.83	0.00	0.83	0.83	NA	NA	NA	NA	NA	NA	0.95	NA	0.972	0.054	0	0	0.000	NA	10.0	NA	10.00
18.3	1.14	1.14	0.00	1.14	1.14	NA	NA	NA	NA	NA	NA	0.95	NA	0.961	0.053	0	0	0.000	NA	10.0	NA	10.00
20.8	1.30	1.30	0.00	1.30	1.30	NA	NA	NA	NA	NA	NA	0.95	NA	0.955	0.053	0	0	0.000	NA	10.0	NA	10.00
23.3	1.45	1.45	0.00	1.45	1.45	NA	NA	NA	NA	NA	NA	0.95	NA	0.948	0.052	0	0	0.000	NA	10.0	NA	10.00
25.8	1.61	1.61	0.00	1.61	1.61	NA	NA	NA	NA	NA	NA	0.95	NA	0.939	0.052	0	0	0.000	NA	10.0	NA	10.00
28.3	1.77	1.77	0.00	1.77	1.77	NA	NA	NA	NA	NA	NA	0.95	NA	0.929	0.051	0	0	0.000	NA	10.0	NA	10.00
30.8	1.92	1.92	0.00	1.92	1.92	NA	NA	NA	NA	NA	NA	0.95	NA	0.917	0.051	0	0	0.000	NA	10.0	NA	10.00
33.3	2.08	2.08	0.00	2.08	2.08	NA	NA	NA	NA	NA	NA	0.95	NA	0.902	0.050	0	0	0.000	NA	10.0	NA	10.00
35.8	2.23	2.23	0.00	2.23	2.23	NA	NA	NA	NA	NA	NA	0.95	NA	0.885	0.049	0	0	0.000	NA	10.0	NA	10.00
38.3	2.39	2.39	0.04	2.35	2.35	NA	NA	NA	NA	NA	NA	0.95	NA	0.866	0.049	0	0	0.000	NA	10.0	NA	10.00
40.8	2.55	2.55	0.12	2.43	2.43	NA	NA	NA	NA	NA	NA	0.95	NA	0.844	0.049	0	0	0.000	NA	10.0	NA	10.00
45.8	2.86	2.86	0.27	2.59	2.59	NA	NA	NA	NA	NA	NA	0.95	NA	0.796	0.049	0	0	0.000	NA	10.0	NA	10.00
48.3	3.02	3.02	0.35	2.66	2.66	NA	NA	NA	NA	NA	NA	0.95	NA	0.771	0.048	0	0	0.000	NA	10.0	NA	10.00
50.8	3.17	3.17	0.43	2.74	2.74	NA	NA	NA	NA	NA	NA	0.95	NA	0.745	0.048	0	0	0.000	NA	10.0	NA	10.00
53.3	3.33	3.33	0.51	2.82	2.82	NA	NA	NA	NA	NA	NA	0.95	NA	0.720	0.047	0	0	0.000	NA	10.0	NA	10.00
55.8	3.48	3.48	0.59	2.90	2.90	NA	NA	NA	NA	NA	NA	0.95	NA	0.696	0.046	0	0	0.000	NA	10.0	NA	10.00
58.3	3.64	3.64	0.66	2.98	2.98	NA	NA	NA	NA	NA	NA	0.95	NA	0.674	0.046	0	0	0.000	NA	10.0	NA	10.00
60.8	3.80	3.80	0.74	3.06	3.06	NA	NA	NA	NA	NA	NA	0.95	NA	0.653	0.045	0	0	0.000	NA	10.0	NA	10.00
63.3	3.95	3.95	0.82	3.13	3.13	NA	NA	NA	NA	NA	NA	0.95	NA	0.634	0.044	0	0	0.000	NA	10.0	NA	10.00
65.8	4.11	4.11	0.90	3.21	3.21	NA	NA	NA	NA	NA	NA	0.95	NA	0.617	0.044	0	0	0.000	NA	10.0	NA	10.00

Clifty Creek AEP, Boring = B-1, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts

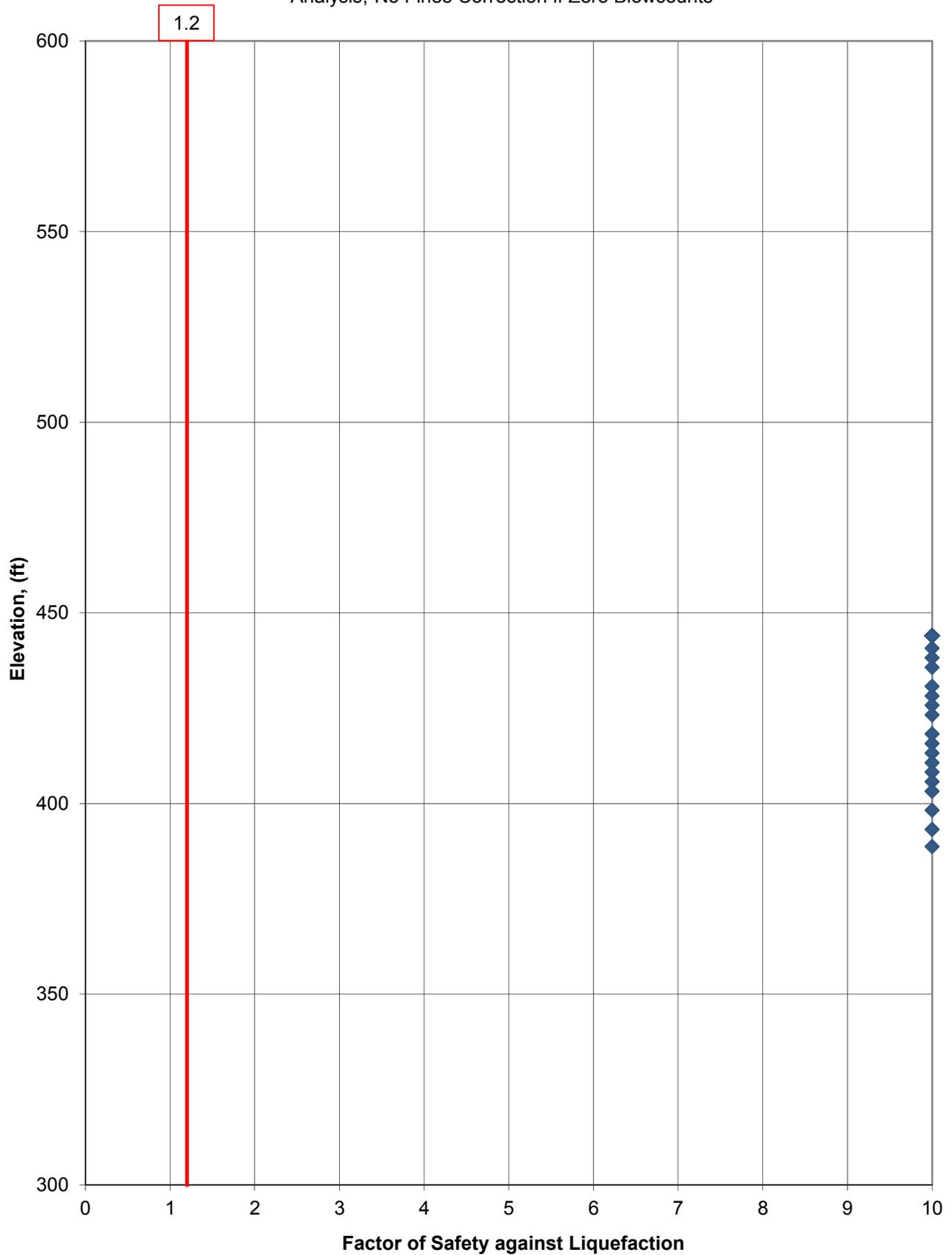


Clifty Creek AEP, Boring = B-1, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts

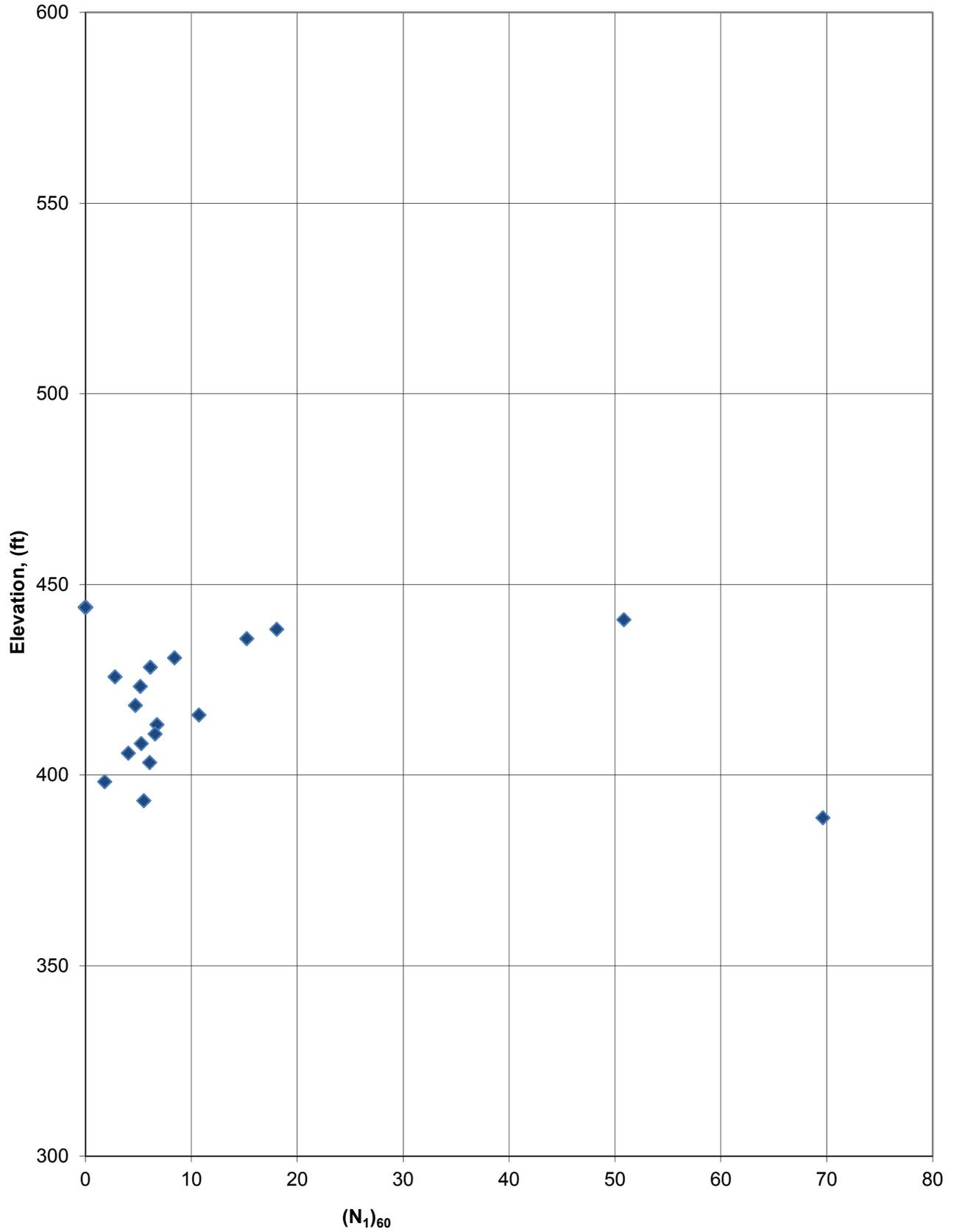


Depth of Mid. Pt. of Sample (ft.)	Vert. Total Stress during EQ (tsf)	Vert. Total Stress during EQ w/ Fill (tsf)	Static Pore Pressure during EQ (tsf)	Vert. Eff. Stress during EQ (tsf)	Vert. Eff. Stress during EQ w/ Fill (tsf)	Alpha I	Beta I	Equivalent Clean Sand N-Value (N ₁) ^{60cs}	CRR7.5	Ksigma	Kalpha	EQ Source		CRR Design EQ	Event (MCE, OBE, etc.)		Using SHAKE Data			Shake Stress Curve Fit Parameters		
												EQ Mag (Mw)	a max (g)		EQ Motion File	Max. Shake Stress (psf) Design EQ	Avg. Shake Stress (psf) Design EQ	CSR eq Design EQ	FS liq Design EQ	FS liq for plot	m4:	m3:	m2:	m1:
z	σ _v	σ _{v with fill}	u	σ' _v	σ' _{v with fill}			N-Value				Mag. Scaling Factor (Cm)	Simplified Stress Reduction Coeff., r _d	Simplified CSR eq Design EQ	0	0	CSR eq Design EQ	FS liq Design EQ	FS liq for plot	FS liq Design EQ	FS liq for plot	
Boring ID: B-2 Top of Fill Elevation: 444.0 Fill Height: 0.0 Fill Total Unit Weight: 125 Fill Total Stress: 0.00						<i>Note: A factor of safety shown as "NA" implies that the soil type is not appropriately evaluated using this methodology. This applies to soils classified as CL, CH, CL-ML and MH. These soils should be evaluated using methods for fine-grained soils. Also, "NA" implies that coarse grained soils with equivalent clean sand N-values greater than 30 are resistant to liquefaction.</i>																
	totstr-top		u-top	effstr-top																		
	0.16		0.00	0.16																		
3.3	0.20	0.20	0.00	0.20	0.20	NA	NA	NA	NA	NA	NA	0.95	NA	0.994	0.055	0	0	0.000	NA	10.0	NA	10.0
5.8	0.36	0.36	0.00	0.36	0.36	NA	NA	NA	NA	NA	NA	0.95	NA	0.989	0.055	0	0	0.000	NA	10.0	NA	10.0
8.3	0.52	0.52	0.00	0.52	0.52	NA	NA	NA	NA	NA	NA	0.95	NA	0.983	0.054	0	0	0.000	NA	10.0	NA	10.0
13.3	0.83	0.83	0.00	0.83	0.83	NA	NA	NA	NA	NA	NA	0.95	NA	0.972	0.054	0	0	0.000	NA	10.0	NA	10.0
15.8	0.98	0.98	0.02	0.96	0.96	NA	NA	NA	NA	NA	NA	0.95	NA	0.967	0.055	0	0	0.000	NA	10.0	NA	10.0
18.3	1.14	1.14	0.10	1.04	1.04	NA	NA	NA	NA	NA	NA	0.95	NA	0.961	0.058	0	0	0.000	NA	10.0	NA	10.0
20.8	1.30	1.30	0.18	1.12	1.12	NA	NA	NA	NA	NA	NA	0.95	NA	0.955	0.061	0	0	0.000	NA	10.0	NA	10.0
25.8	1.61	1.61	0.34	1.27	1.27	NA	NA	NA	NA	NA	NA	0.95	NA	0.939	0.066	0	0	0.000	NA	10.0	NA	10.0
28.3	1.77	1.77	0.41	1.35	1.35	NA	NA	NA	NA	NA	NA	0.95	NA	0.929	0.067	0	0	0.000	NA	10.0	NA	10.0
30.8	1.92	1.92	0.49	1.43	1.43	NA	NA	NA	NA	NA	NA	0.95	NA	0.917	0.068	0	0	0.000	NA	10.0	NA	10.0
33.3	2.08	2.08	0.57	1.51	1.51	NA	NA	NA	NA	NA	NA	0.95	NA	0.902	0.069	0	0	0.000	NA	10.0	NA	10.0
35.8	2.23	2.23	0.65	1.59	1.59	NA	NA	NA	NA	NA	NA	0.95	NA	0.885	0.069	0	0	0.000	NA	10.0	NA	10.0
38.3	2.39	2.39	0.73	1.67	1.67	NA	NA	NA	NA	NA	NA	0.95	NA	0.866	0.069	0	0	0.000	NA	10.0	NA	10.0
40.8	2.55	2.55	0.80	1.74	1.74	NA	NA	NA	NA	NA	NA	0.95	NA	0.844	0.068	0	0	0.000	NA	10.0	NA	10.0
45.8	2.86	2.86	0.96	1.90	1.90	NA	NA	NA	NA	NA	NA	0.95	NA	0.796	0.066	0	0	0.000	NA	10.0	NA	10.0
50.8	3.17	3.17	1.12	2.06	2.06	NA	NA	NA	NA	NA	NA	0.95	NA	0.745	0.063	0	0	0.000	NA	10.0	NA	10.0
55.3	3.45	3.45	1.26	2.20	2.20	0.02	1.00	70	NA	0.781	1.000	0.95	NA	0.701	0.061	0	0	0.000	NA	10.0	NA	10.0

Clifty Creek AEP, Boring = B-2, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts

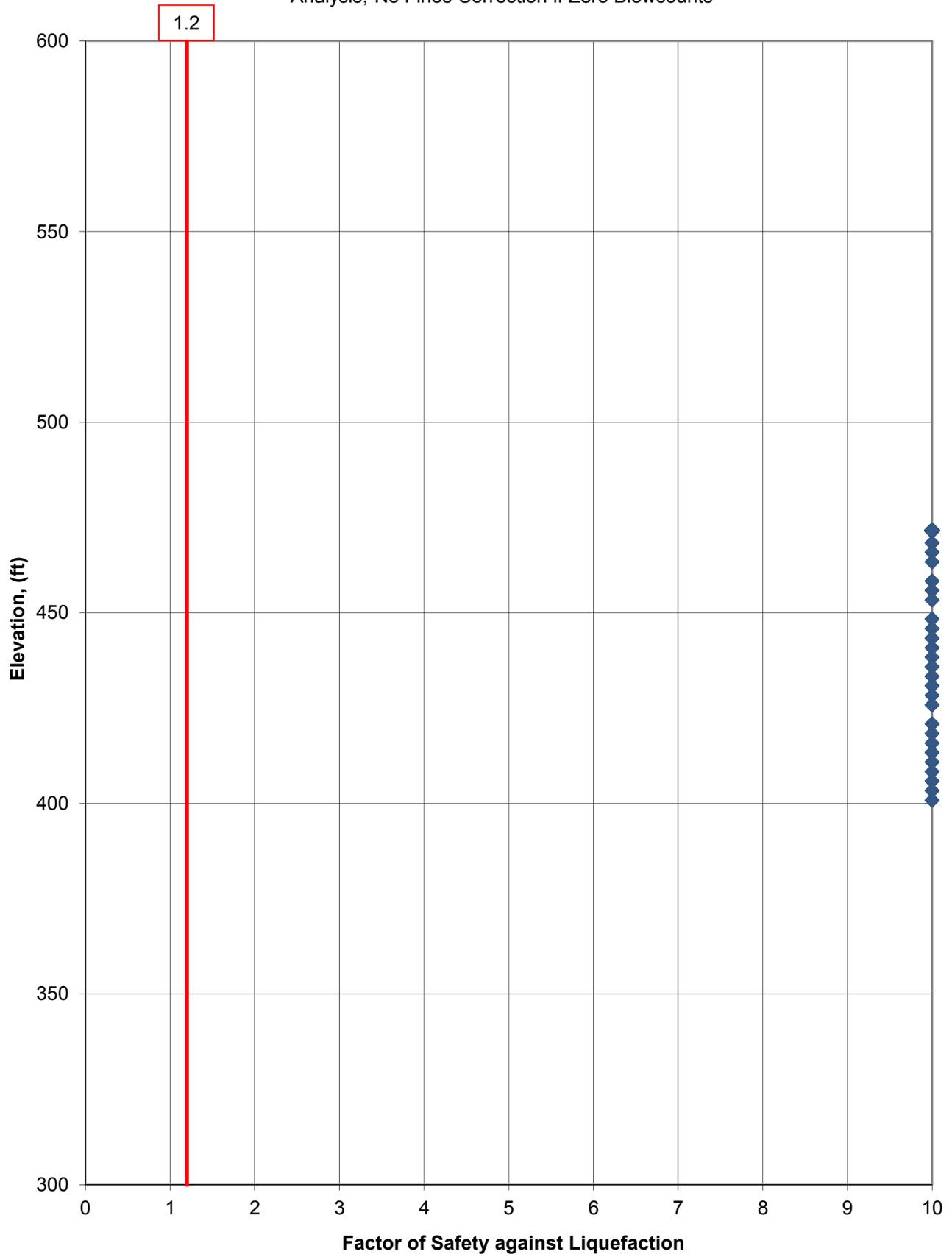


Clifty Creek AEP, Boring = B-2, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts

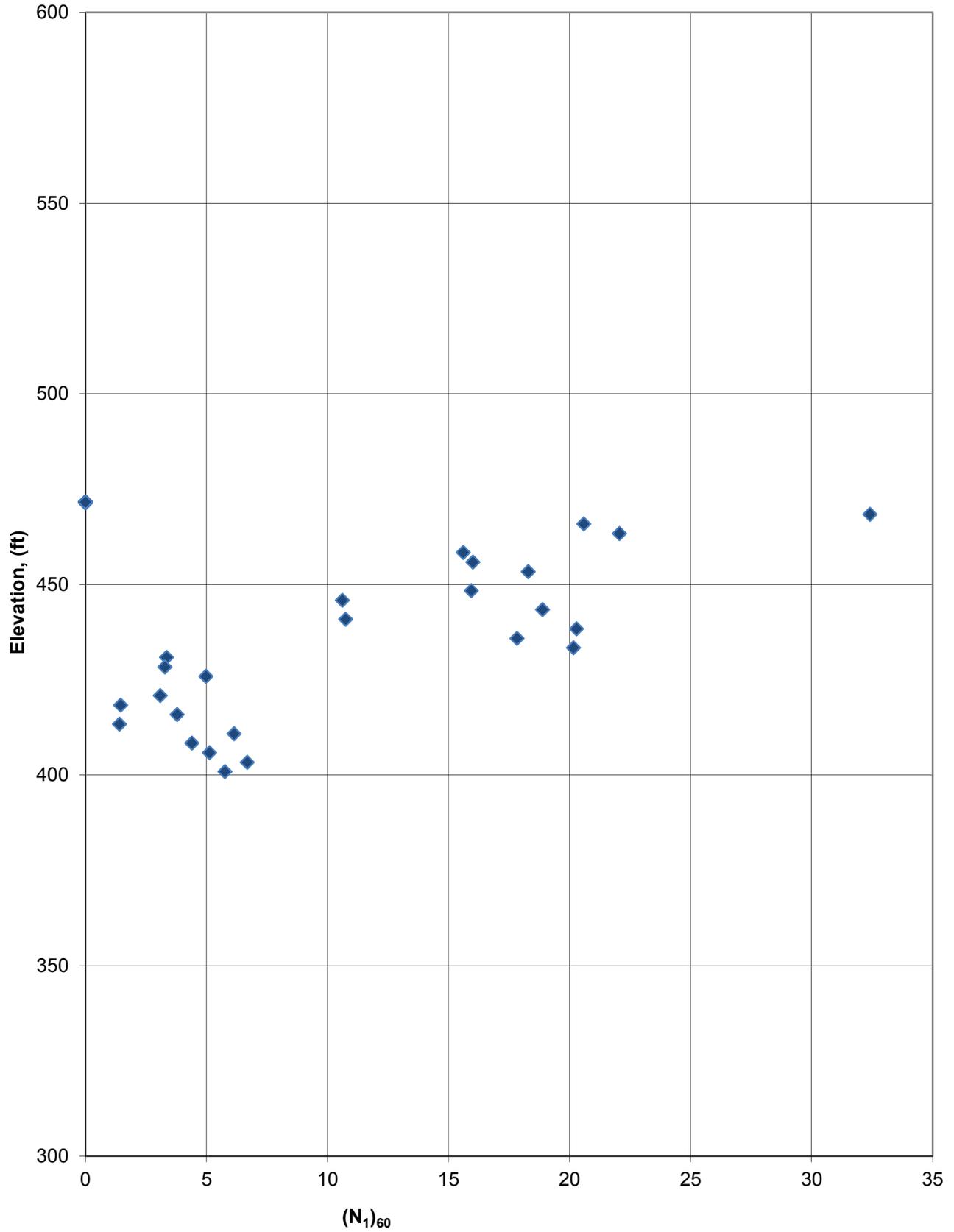


Depth of Mid. Pt. of Sample (ft.)	Vert. Total Stress during EQ (tsf)	Vert. Total Stress during EQ w/ Fill (tsf)	Static Pore Pressure during EQ (tsf)	Vert. Eff. Stress during EQ (tsf)	Vert. Eff. Stress during EQ w/ Fill (tsf)	Alpha I	Beta I	Equivalent Clean Sand N-Value (N ₁) ^{60cs}	CRR7.5	Ksigma	Kalpha	EQ Source		CRR	Event (MCE, OBE, etc.)		Avg. Shake Stress (psf) Design EQ	Using SHAKE Data			Shake Stress Curve Fit Parameters	
												EQ Mag (Mw)	a max (g)		EQ Motion File	Max. Shake Stress (psf) Design EQ		CSR eq	FS liq	FS liq	m4:	m3:	m2:	m1:
z	σ _v	σ _v with fill	u	σ' _v	σ' _v with fill							EQ Mag (Mw)	a max (g)	EQ Motion File			CSR eq	FS liq	FS liq	FS liq	FS liq	
						Boring ID: B-3		<p>Note: A factor of safety shown as "NA" implies that the soil type is not appropriately evaluated using this methodology. This applies to soils classified as CL, CH, CL-ML and MH. These soils should be evaluated using methods for fine-grained soils. Also, "NA" implies that coarse grained soils with equivalent clean sand N-values greater than 30 are resistant to liquefaction.</p>														
						Top of Fill Elevation: 471.6																
						Fill Height: 0.0																
						Fill Total Unit Weight: 125																
						Fill Total Stress: 0.00																
	totstr-top		u-top	effstr-top																		
	0.16		0.00	0.16																		
3.3	0.20	0.20	0.00	0.20	0.20	NA	NA	NA	NA	NA	NA	0.95	NA	0.994	0.055	0	0	0.000	NA	10.0	NA	10.00
5.8	0.36	0.36	0.00	0.36	0.36	NA	NA	NA	NA	NA	NA	0.95	NA	0.989	0.055	0	0	0.000	NA	10.0	NA	10.00
8.3	0.52	0.52	0.00	0.52	0.52	NA	NA	NA	NA	NA	NA	0.95	NA	0.983	0.054	0	0	0.000	NA	10.0	NA	10.00
13.3	0.83	0.83	0.00	0.83	0.83	NA	NA	NA	NA	NA	NA	0.95	NA	0.972	0.054	0	0	0.000	NA	10.0	NA	10.00
15.8	0.98	0.98	0.00	0.98	0.98	NA	NA	NA	NA	NA	NA	0.95	NA	0.967	0.053	0	0	0.000	NA	10.0	NA	10.00
18.3	1.14	1.14	0.00	1.14	1.14	NA	NA	NA	NA	NA	NA	0.95	NA	0.961	0.053	0	0	0.000	NA	10.0	NA	10.00
23.3	1.45	1.45	0.00	1.45	1.45	NA	NA	NA	NA	NA	NA	0.95	NA	0.948	0.052	0	0	0.000	NA	10.0	NA	10.00
25.8	1.61	1.61	0.00	1.61	1.61	NA	NA	NA	NA	NA	NA	0.95	NA	0.939	0.052	0	0	0.000	NA	10.0	NA	10.00
28.3	1.77	1.77	0.00	1.77	1.77	NA	NA	NA	NA	NA	NA	0.95	NA	0.929	0.051	0	0	0.000	NA	10.0	NA	10.00
30.8	1.92	1.92	0.00	1.92	1.92	NA	NA	NA	NA	NA	NA	0.95	NA	0.917	0.051	0	0	0.000	NA	10.0	NA	10.00
33.3	2.08	2.08	0.00	2.08	2.08	NA	NA	NA	NA	NA	NA	0.95	NA	0.902	0.050	0	0	0.000	NA	10.0	NA	10.00
35.8	2.23	2.23	0.00	2.23	2.23	NA	NA	NA	NA	NA	NA	0.95	NA	0.885	0.049	0	0	0.000	NA	10.0	NA	10.00
38.3	2.39	2.39	0.07	2.32	2.32	NA	NA	NA	NA	NA	NA	0.95	NA	0.866	0.049	0	0	0.000	NA	10.0	NA	10.00
40.8	2.55	2.55	0.15	2.40	2.40	NA	NA	NA	NA	NA	NA	0.95	NA	0.844	0.050	0	0	0.000	NA	10.0	NA	10.00
43.3	2.70	2.70	0.23	2.48	2.48	NA	NA	NA	NA	NA	NA	0.95	NA	0.821	0.049	0	0	0.000	NA	10.0	NA	10.00
45.8	2.86	2.86	0.30	2.56	2.56	NA	NA	NA	NA	NA	NA	0.95	NA	0.796	0.049	0	0	0.000	NA	10.0	NA	10.00
50.8	3.17	3.17	0.46	2.71	2.71	NA	NA	NA	NA	NA	NA	0.95	NA	0.745	0.048	0	0	0.000	NA	10.0	NA	10.00
53.3	3.33	3.33	0.54	2.79	2.79	NA	NA	NA	NA	NA	NA	0.95	NA	0.720	0.047	0	0	0.000	NA	10.0	NA	10.00
55.8	3.48	3.48	0.62	2.87	2.87	NA	NA	NA	NA	NA	NA	0.95	NA	0.696	0.047	0	0	0.000	NA	10.0	NA	10.00
58.3	3.64	3.64	0.69	2.95	2.95	NA	NA	NA	NA	NA	NA	0.95	NA	0.674	0.046	0	0	0.000	NA	10.0	NA	10.00
60.8	3.80	3.80	0.77	3.02	3.02	NA	NA	NA	NA	NA	NA	0.95	NA	0.653	0.045	0	0	0.000	NA	10.0	NA	10.00
63.3	3.95	3.95	0.85	3.10	3.10	NA	NA	NA	NA	NA	NA	0.95	NA	0.634	0.045	0	0	0.000	NA	10.0	NA	10.00
65.8	4.11	4.11	0.93	3.18	3.18	NA	NA	NA	NA	NA	NA	0.95	NA	0.617	0.044	0	0	0.000	NA	10.0	NA	10.00
68.3	4.27	4.27	1.01	3.26	3.26	NA	NA	NA	NA	NA	NA	0.95	NA	0.602	0.044	0	0	0.000	NA	10.0	NA	10.00
70.8	4.42	4.42	1.08	3.34	3.34	NA	NA	NA	NA	NA	NA	0.95	NA	0.588	0.043	0	0	0.000	NA	10.0	NA	10.00

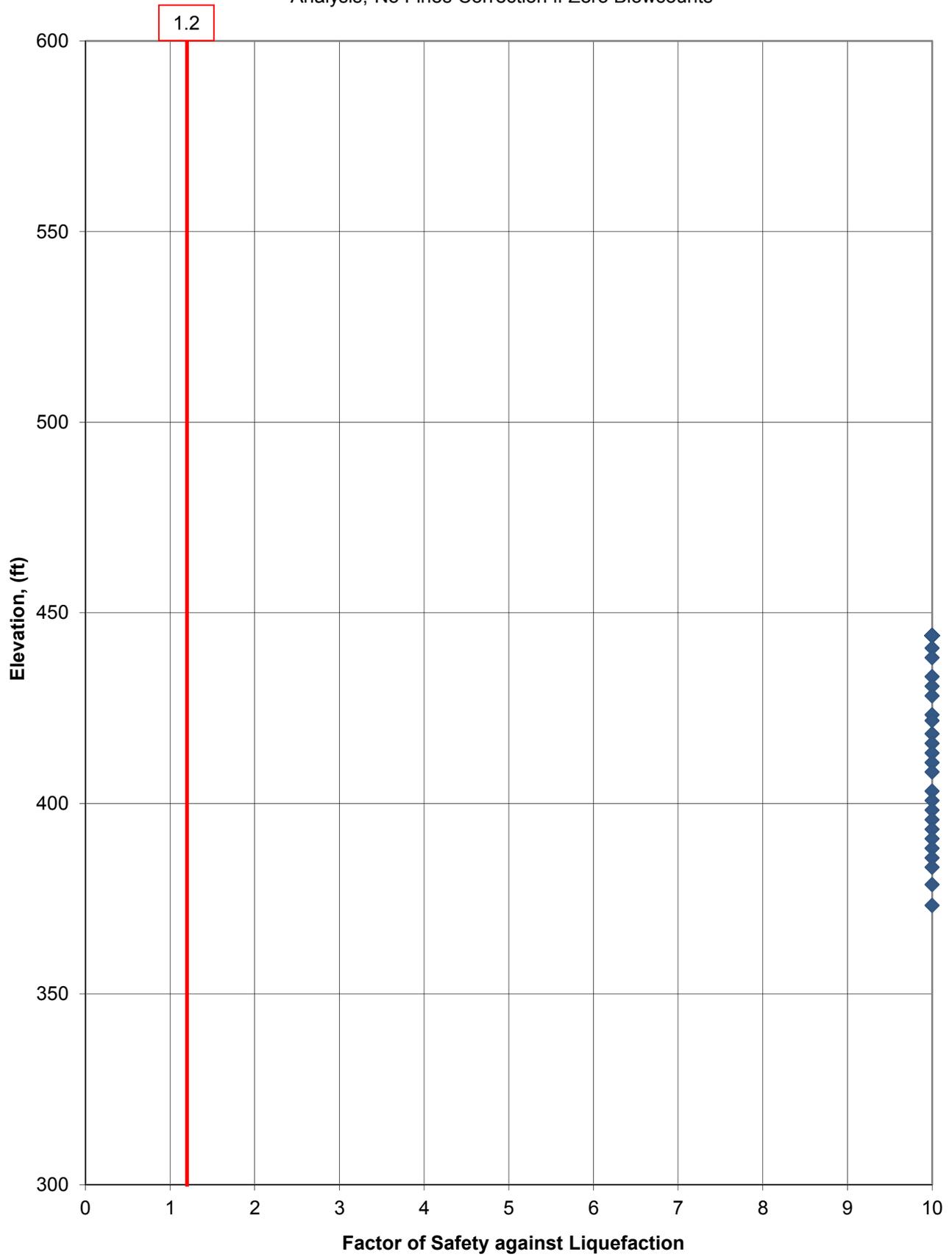
Clifty Creek AEP, Boring = B-3, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts



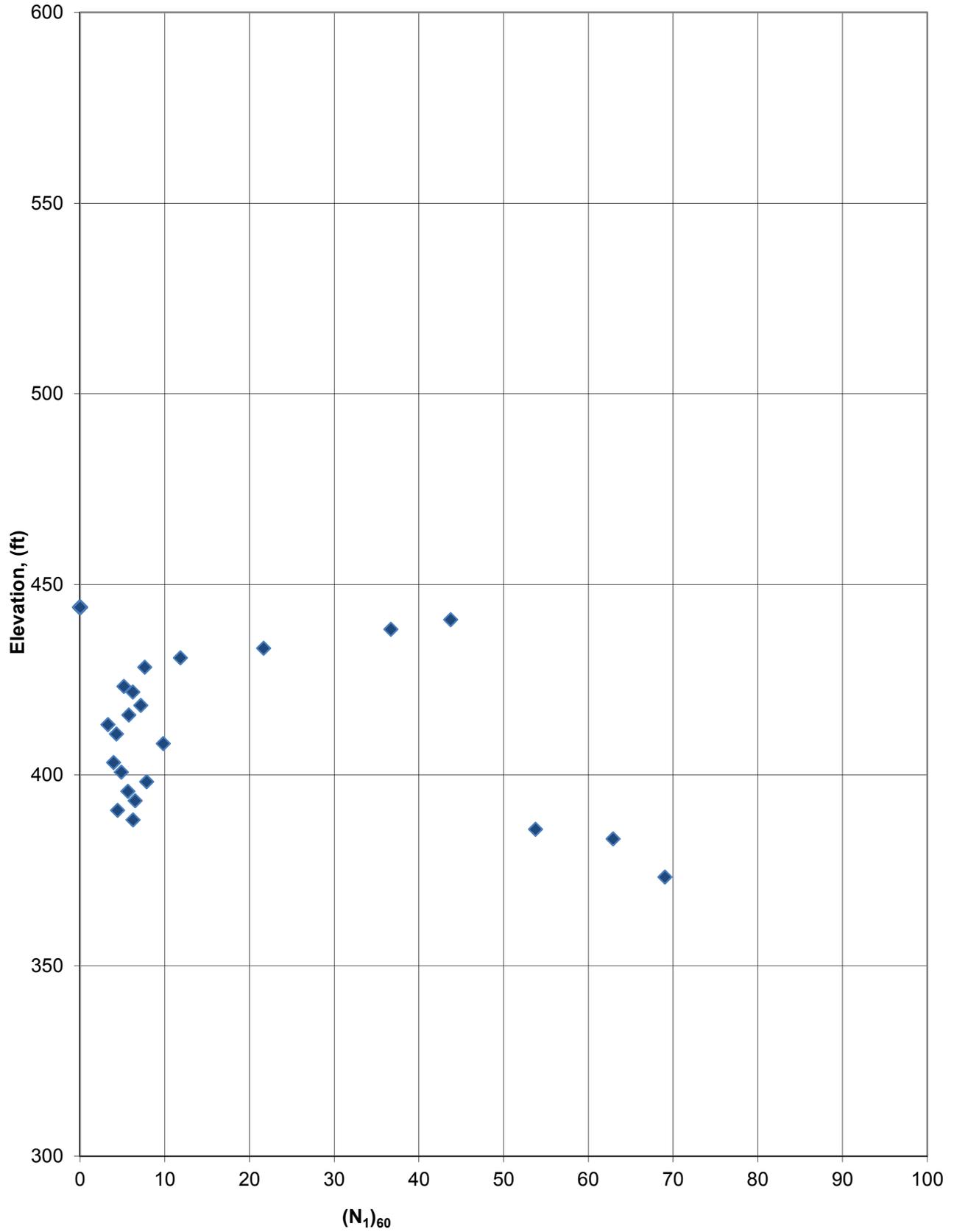
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NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts



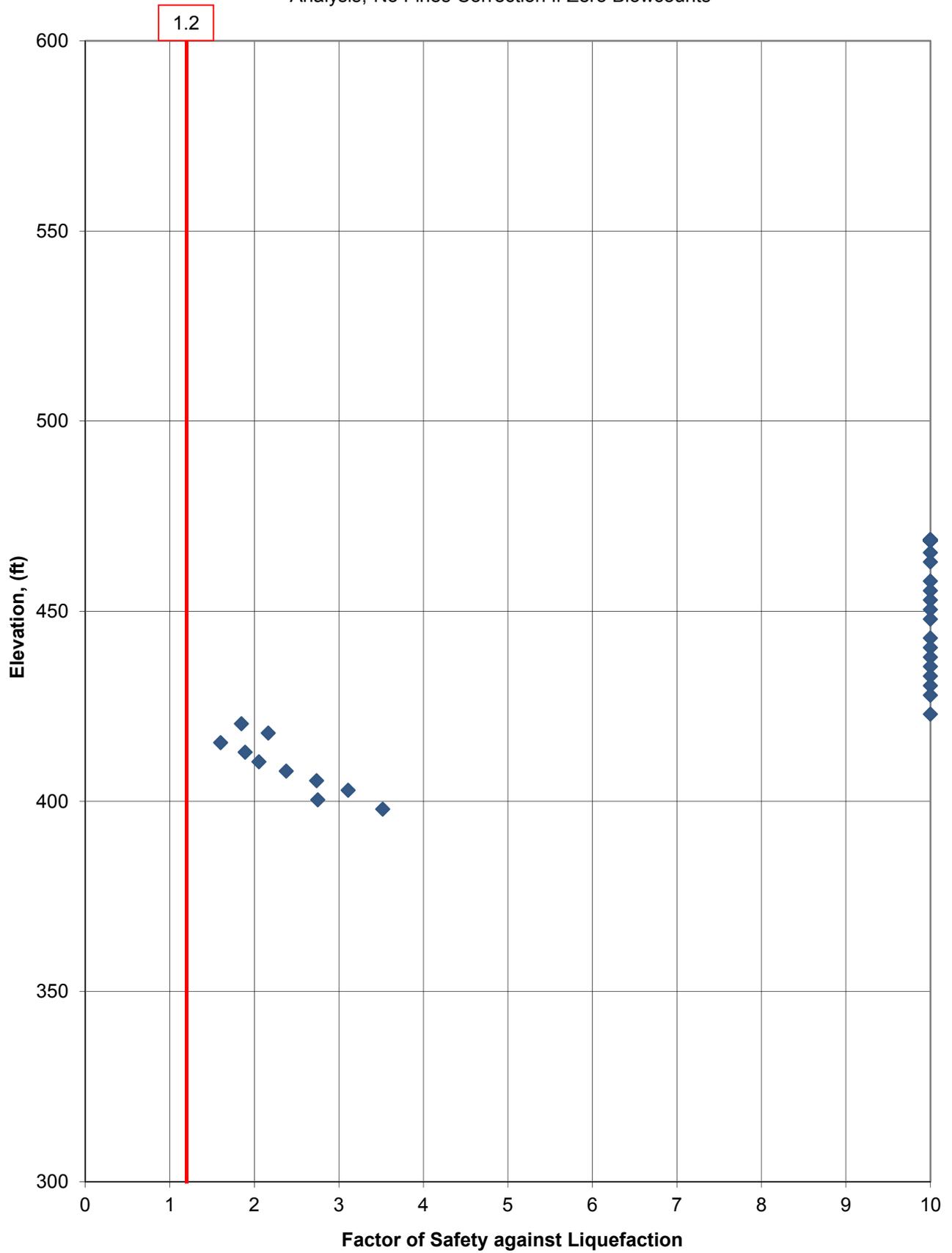
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NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts



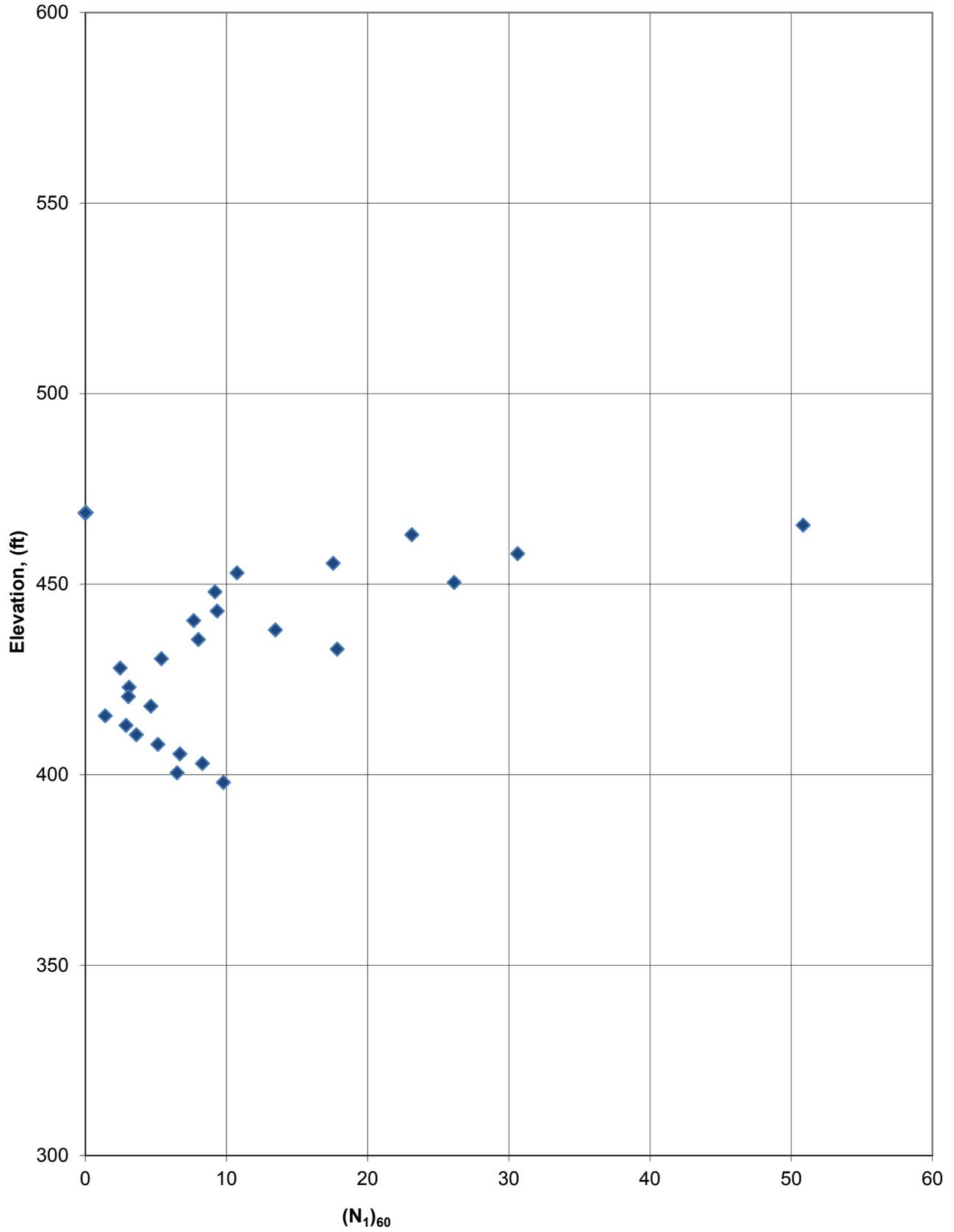
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NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts



Clifty Creek AEP, Boring = B-5, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts

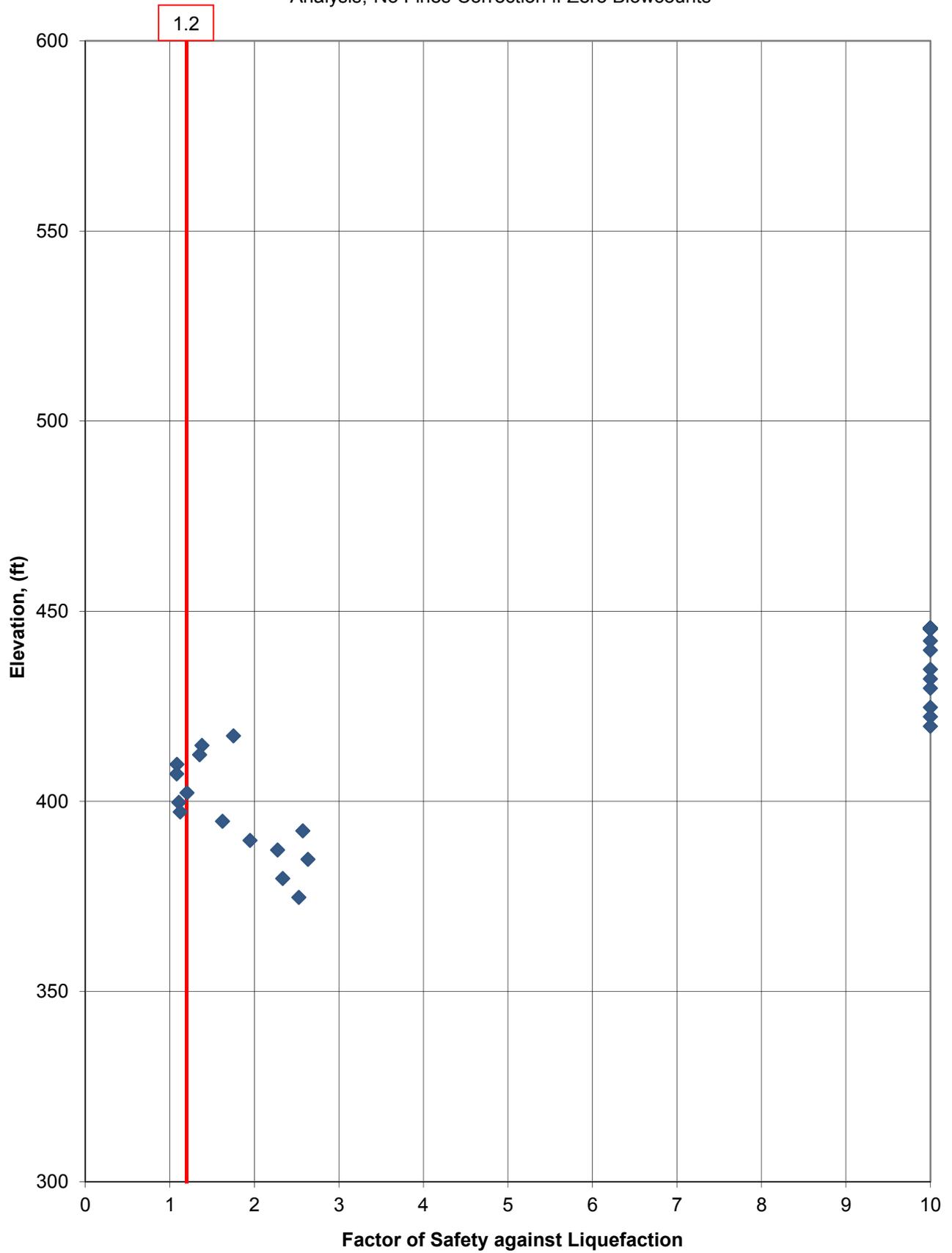


Clifty Creek AEP, Boring = B-5, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts

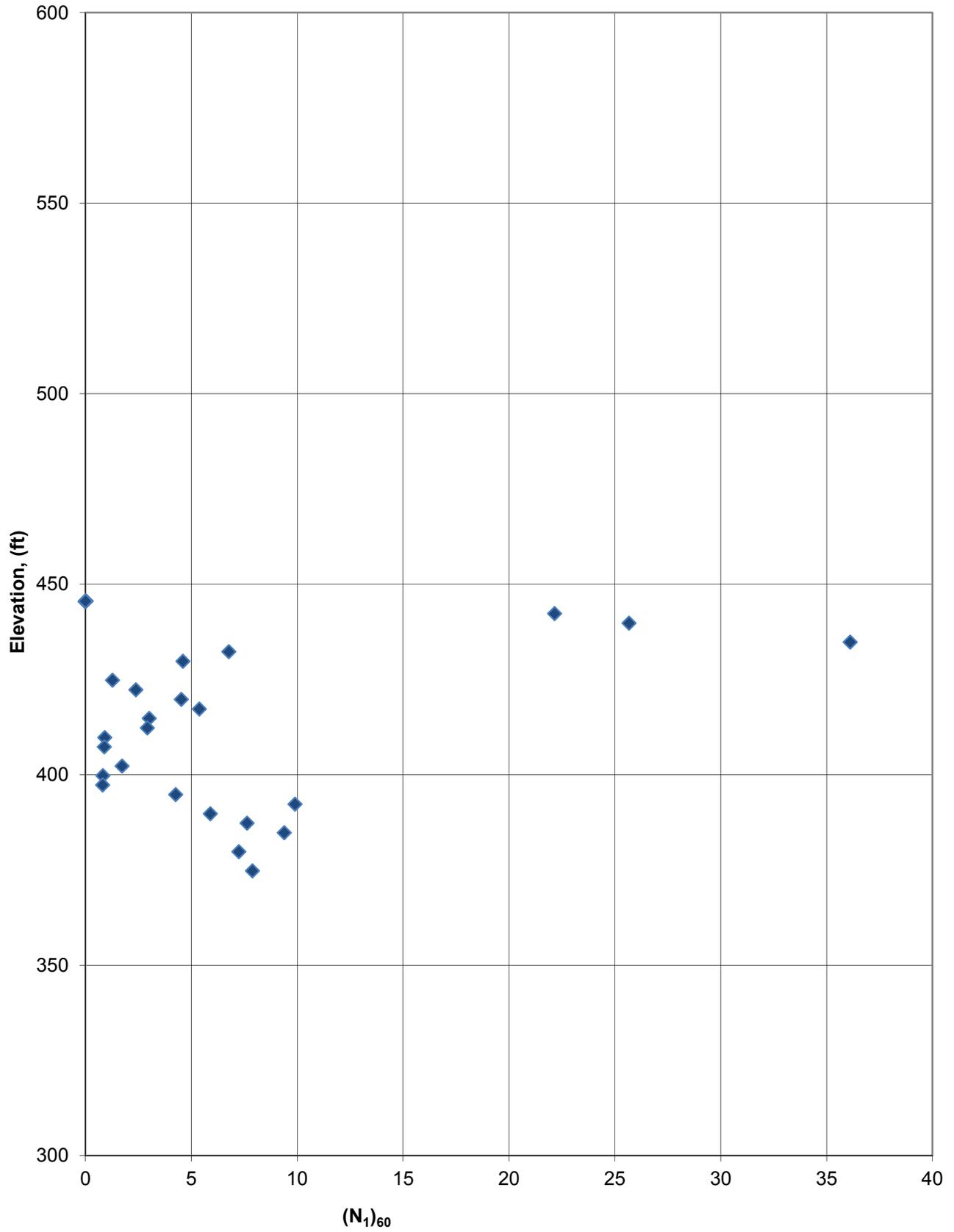


Depth of Mid. Pt. of Sample (ft.)	Vert. Total Stress during EQ (tsf)	Vert. Total Stress during EQ w/ Fill (tsf)	Static Pore Pressure during EQ (tsf)	Vert. Eff. Stress during EQ (tsf)	Vert. Eff. Stress during EQ w/ Fill (tsf)	Alpha I	Beta I	Equivalent Clean Sand N-Value (N ₁) ^{60cs}	CRR7.5	Ksigma	Kalpha	EQ Source		Event (MCE, OBE, etc.)		Shake Stress Curve Fit Parameters									
												0	a max (g) 0.085	0	EQ Motion File 0	m4:	m3:	m2:	m1:						
z	σ _v	σ _v with fill	u	σ' _v	σ' _v with fill							Mag. Scaling	CRR	Simplified Stress Reduction	Simplified CSR eq	Max. Shake Stress (psf)	Avg. Shake Stress (psf)	Using SHAKE Data			Simplified				
												Factor (Cm)	Design EQ	Coeff., r _d	Design EQ	Design EQ	Design EQ	CSR eq	FS liq	FS liq	FS liq	FS liq			
																					for plot	for plot			
						Boring ID: B-6		<p>Note: A factor of safety shown as "NA" implies that the soil type is not appropriately evaluated using this methodology. This applies to soils classified as CL, CH, CL-ML and MH. These soils should be evaluated using methods for fine-grained soils. Also, "NA" implies that coarse grained soils with equivalent clean sand N-values greater than 30 are resistant to liquefaction.</p>																	
						Top of Fill Elevation: 445.5																			
						Fill Height: 0.0																			
						Fill Total Unit Weight: 125																			
						Fill Total Stress: 0.00																			
	totstr-top		u-top	effstr-top																					
	0.16		0.00	0.16																					
3.3	0.20	0.20	0.00	0.20	0.20	NA	NA	NA	NA	NA	NA	0.95	NA	0.994	0.055	0	0	0.000	NA	10.0	NA	10.0			
5.8	0.36	0.36	0.00	0.36	0.36	NA	NA	NA	NA	NA	NA	0.95	NA	0.989	0.055	0	0	0.000	NA	10.0	NA	10.0			
10.8	0.67	0.67	0.00	0.67	0.67	NA	NA	NA	NA	NA	NA	0.95	NA	0.978	0.054	0	0	0.000	NA	10.0	NA	10.0			
13.3	0.83	0.83	0.00	0.83	0.83	NA	NA	NA	NA	NA	NA	0.95	NA	0.972	0.054	0	0	0.000	NA	10.0	NA	10.0			
15.8	0.98	0.98	0.02	0.96	0.96	NA	NA	NA	NA	NA	NA	0.95	NA	0.967	0.055	0	0	0.000	NA	10.0	NA	10.0			
20.8	1.30	1.30	0.18	1.12	1.12	NA	NA	NA	NA	NA	NA	0.95	NA	0.955	0.061	0	0	0.000	NA	10.0	NA	10.0			
23.3	1.45	1.45	0.26	1.20	1.20	NA	NA	NA	NA	NA	NA	0.95	NA	0.948	0.064	0	0	0.000	NA	10.0	NA	10.0			
25.8	1.61	1.61	0.34	1.27	1.27	NA	NA	NA	NA	NA	NA	0.95	NA	0.939	0.066	0	0	0.000	NA	10.0	NA	10.0			
28.3	1.77	1.77	0.41	1.35	1.35	5.00	1.20	11	0.126	0.981	1.000	0.95	0.117	0.929	0.067	0	0	0.000	#DIV/0!	#DIV/0!	1.8	1.75			
30.8	1.92	1.92	0.49	1.43	1.43	5.00	1.20	9	0.101	0.979	1.000	0.95	0.094	0.917	0.068	0	0	0.000	#DIV/0!	#DIV/0!	1.4	1.38			
33.3	2.08	2.08	0.57	1.51	1.51	5.00	1.20	9	0.100	0.977	1.000	0.95	0.093	0.902	0.069	0	0	0.000	#DIV/0!	#DIV/0!	1.4	1.35			
35.8	2.23	2.23	0.65	1.59	1.59	5.00	1.20	6	0.080	0.978	1.000	0.95	0.075	0.885	0.069	0	0	0.000	#DIV/0!	#DIV/0!	1.1	1.08			
38.3	2.39	2.39	0.73	1.67	1.67	5.00	1.20	6	0.080	0.976	1.000	0.95	0.074	0.866	0.069	0	0	0.000	#DIV/0!	#DIV/0!	1.1	1.08			
43.3	2.70	2.70	0.88	1.82	1.82	5.00	1.20	7	0.088	0.967	1.000	0.95	0.081	0.821	0.067	0	0	0.000	#DIV/0!	#DIV/0!	1.2	1.20			
45.8	2.86	2.86	0.96	1.90	1.90	5.00	1.20	6	0.080	0.969	1.000	0.95	0.073	0.796	0.066	0	0	0.000	#DIV/0!	#DIV/0!	1.1	1.11			
48.3	3.02	3.02	1.04	1.98	1.98	5.00	1.20	6	0.079	0.967	1.000	0.95	0.073	0.771	0.065	0	0	0.000	#DIV/0!	#DIV/0!	1.1	1.12			
50.8	3.17	3.17	1.12	2.06	2.06	5.00	1.20	10	0.114	0.952	1.000	0.95	0.103	0.745	0.063	0	0	0.000	#DIV/0!	#DIV/0!	1.6	1.62			
53.3	3.33	3.33	1.19	2.13	2.13	5.00	1.20	17	0.180	0.938	1.000	0.95	0.160	0.720	0.062	0	0	0.000	#DIV/0!	#DIV/0!	2.6	2.57			
55.8	3.48	3.48	1.27	2.21	2.21	5.00	1.20	12	0.132	0.944	1.000	0.95	0.118	0.696	0.061	0	0	0.000	#DIV/0!	#DIV/0!	1.9	1.95			
58.3	3.64	3.64	1.35	2.29	2.29	5.00	1.20	14	0.152	0.935	1.000008	0.95	0.135	0.674	0.059	0	0	0.000	#DIV/0!	#DIV/0!	2.3	2.27			
60.8	3.80	3.80	1.43	2.37	2.37	5.00	1.20	16	0.173	0.928	1.000011	0.95	0.152	0.653	0.058	0	0	0.000	#DIV/0!	#DIV/0!	2.6	2.64			
65.8	4.11	4.11	1.58	2.53	2.53	5.00	1.20	14	0.147	0.928	1.000007	0.95	0.130	0.617	0.055	0	0	0.000	#DIV/0!	#DIV/0!	2.3	2.34			
70.8	4.42	4.42	1.74	2.68	2.68	5.00	1.20	14	0.155	0.922	1.000008	0.95	0.135	0.588	0.054	0	0	0.000	#DIV/0!	#DIV/0!	2.5	2.53			

Clifty Creek AEP, Boring = B-6, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts

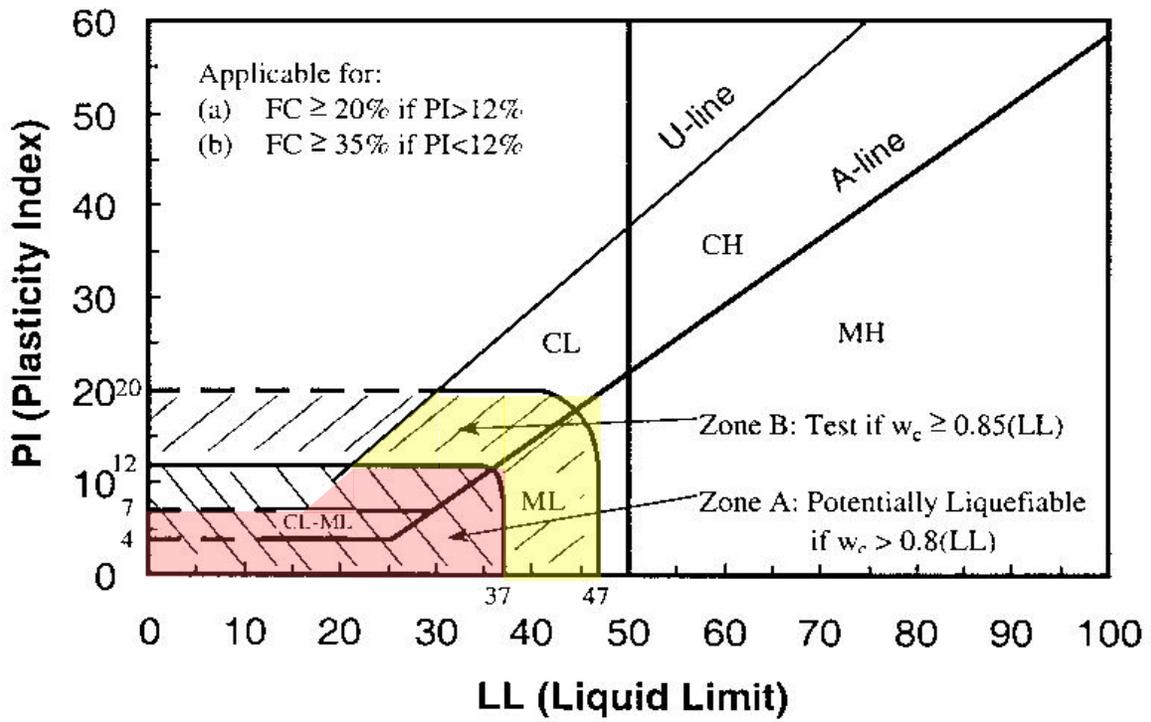


Clifty Creek AEP, Boring = B-6, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts

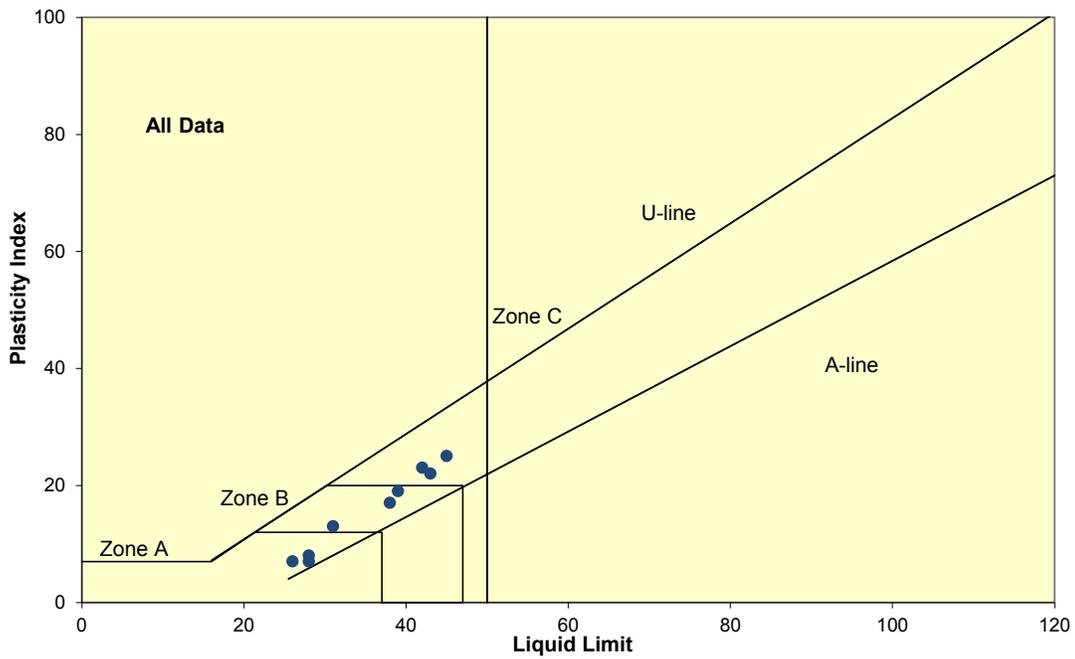


LANDFILL RUNOFF COLLECTION POND:
2015 CCR MANDATE

FINE-GRAINED ANALYSIS

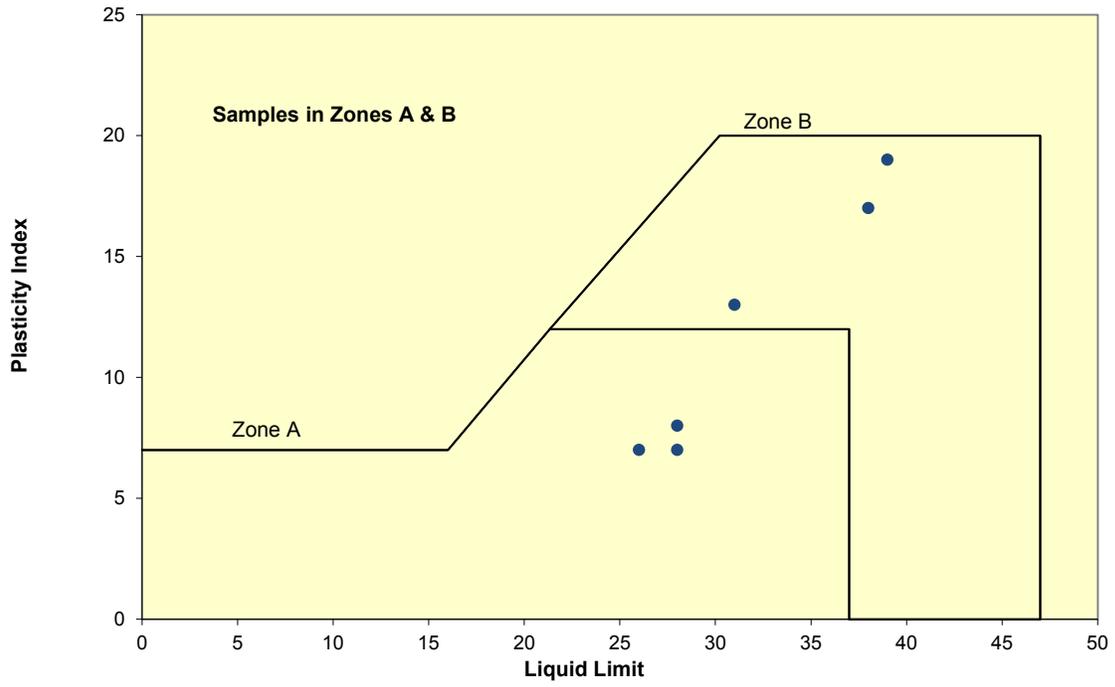


(a)

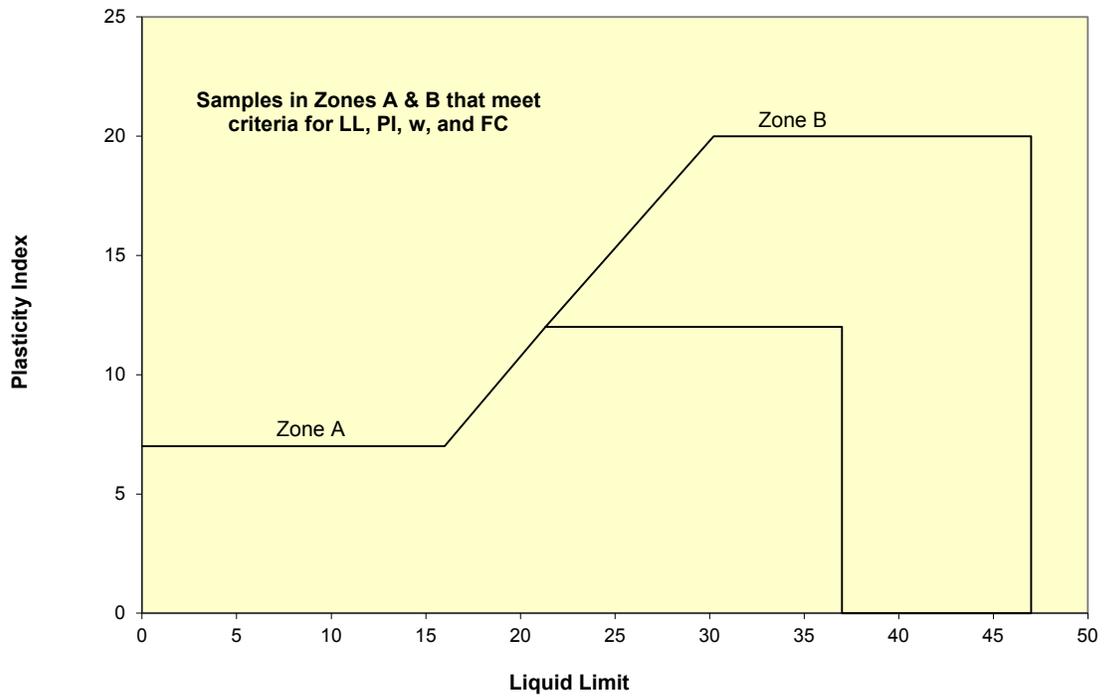


(b)

Screening Criteria for Liquefiable Fine-Grained Soils (Seed et al. 2003)

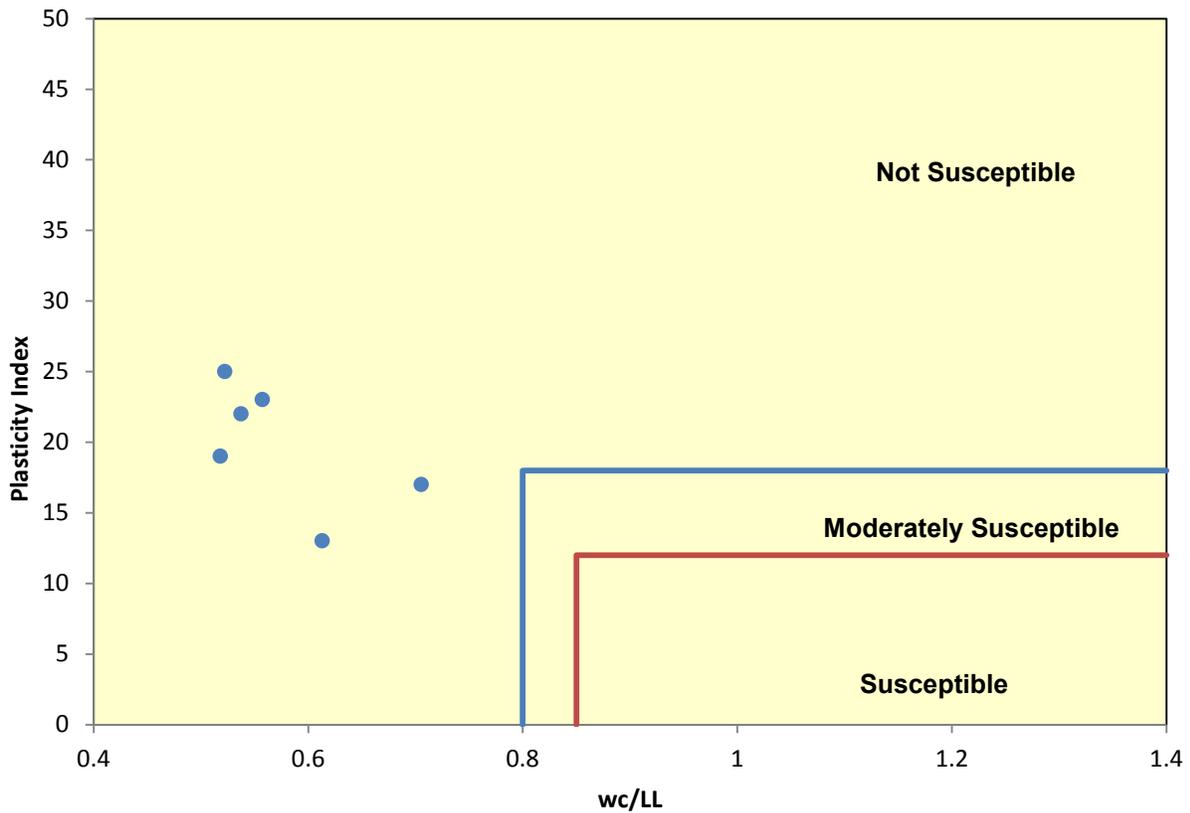
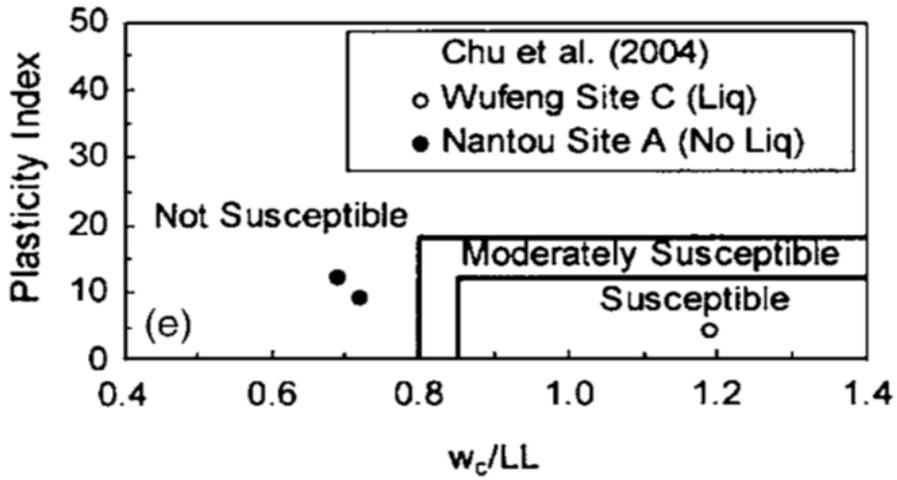


(c)



(d)

Screening Criteria for Liquefiable Fine-Grained Soils (Seed et al. 2003)



Screening Criteria for Assessing Liquefaction in Fine Grained Soils (Bray and Sancio 2006)

COARSE-GRAINED ANALYSIS

EQ Source
0
a max (g)
0.085
EQ Mag (Mw)
7.7
Mag. Scaling

Event (MCE, OBE, etc.)

0

EQ Motion File

0

Shake Stress Curve Fit Parameters

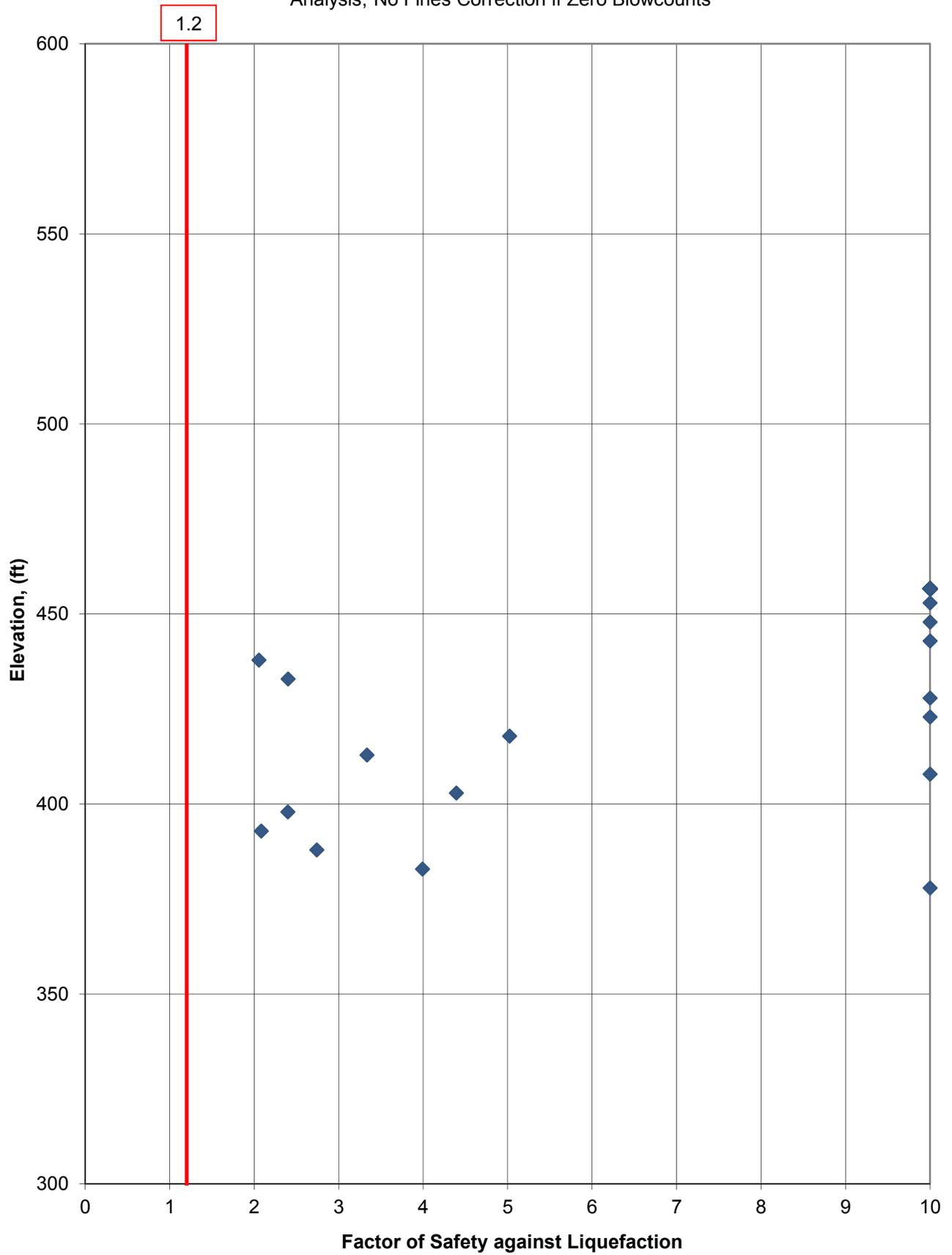
m4:	0
m3:	0
m2:	0
m1:	0

Depth of Mid. Pt. of Sample (ft.)	Vert. Total Stress during EQ (tsf)	Vert. Total Stress during EQ w/ Fill (tsf)	Static Pore Pressure during EQ (tsf)	Vert. Eff. Stress during EQ (tsf)	Vert. Eff. Stress during EQ w/ Fill (tsf)	Alpha I	Beta I	Equivalent Clean Sand N-Value (N1) ^{60CS}	CRR7.5	Ksigma	Kalpha	Factor (Cm)	Design EQ	Simplified Stress Reduction	Simplified CSR eq	Max. Shake Stress (psf)	Avg. Shake Stress (psf)	Using SHAKE Data			Simplified	
														Coeff., r _d	Design EQ			Design EQ	Design EQ	Design EQ	FS liq for plot	FS liq for plot

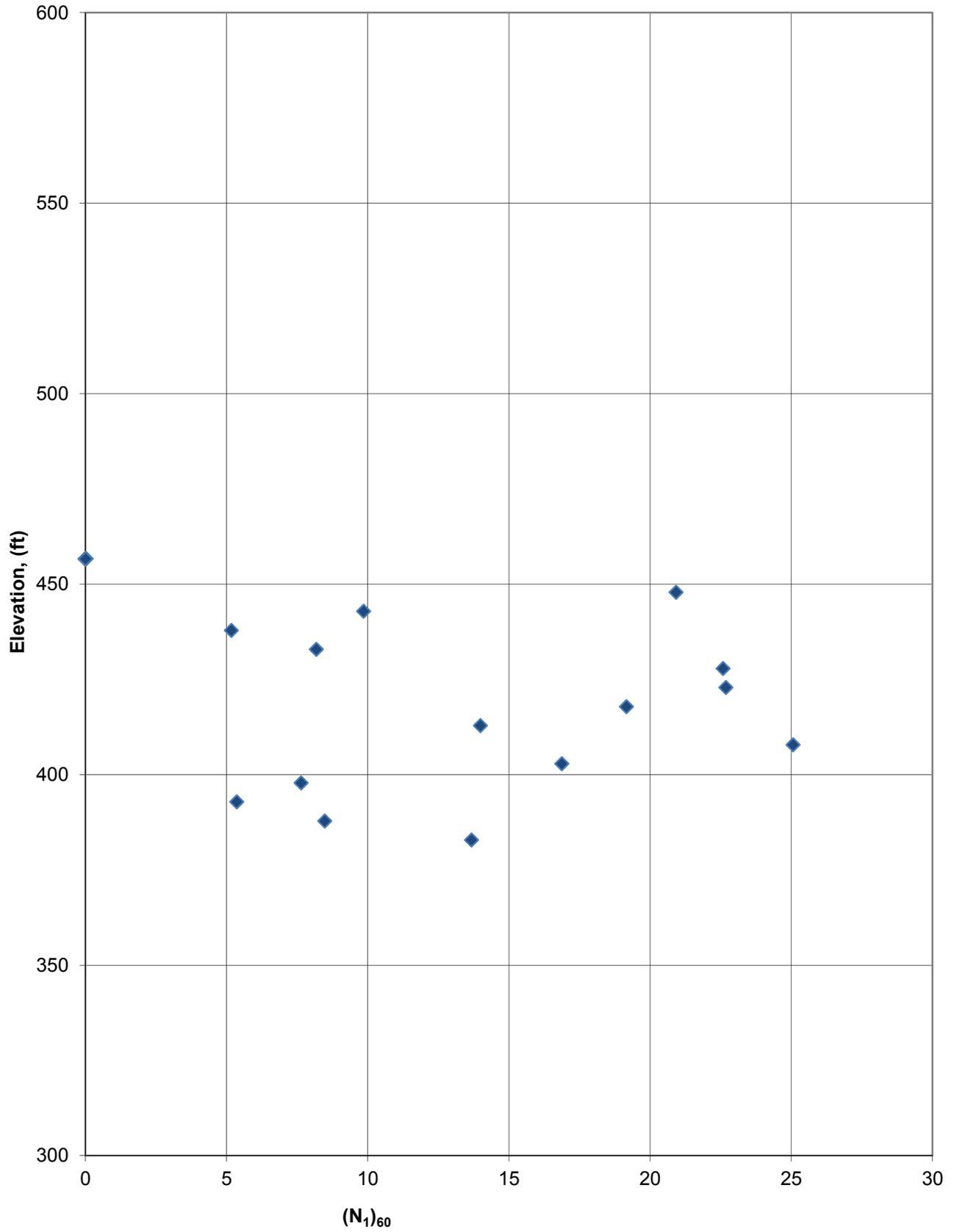
Note: A factor of safety shown as "NA" implies that the soil type is not appropriately evaluated using this methodology. This applies to soils classified as CL, CH, CL-ML and MH. These soils should be evaluated using methods for fine-grained soils. Also, "NA" implies that coarse grained soils with equivalent clean sand N-values greater than 30 are resistant to liquefaction.

						Boring ID: SI-1																
						Top of Fill Elevation: 456.6																
						Fill Height: 0.0																
						Fill Total Unit Weight: 125																
						Fill Total Stress: 0.00																
		tolstr-top 0.19		u-top 0.00		effstr-top 0.19																
3.8	0.23	0.23	0.00	0.23	0.23	5.00	1.20	46	NA	1.000	1.000	0.95	NA	0.993	0.055	0	0	0.000	NA	10.0	NA	10.0
8.8	0.55	0.55	0.00	0.55	0.55	5.00	1.20	30	NA	1.000	1.000	0.95	NA	0.982	0.054	0	0	0.000	NA	10.0	NA	10.0
13.8	0.86	0.86	0.00	0.86	0.86	5.00	1.20	17	NA	1.000	1.000	0.95	NA	0.971	0.054	0	0	0.000	NA	10.0	NA	10.00
18.8	1.17	1.17	0.15	1.02	1.02	5.00	1.20	11	0.124	1.000	1.000	0.95	0.117	0.960	0.061	0	0	0.000	#DIV/0!	#DIV/0!	2.1	2.06
23.8	1.48	1.48	0.30	1.18	1.18	5.00	1.20	15	0.158	0.991	1.000	0.95	0.149	0.946	0.066	0	0	0.000	#DIV/0!	#DIV/0!	2.4	2.40
28.8	1.80	1.80	0.46	1.34	1.34	5.00	1.20	32	NA	0.966	1.000	0.95	NA	0.927	0.069	0	0	0.000	NA	10.0	NA	10.00
33.8	2.11	2.11	0.62	1.49	1.49	5.00	1.20	32	NA	0.950	1.000	0.95	NA	0.899	0.070	0	0	0.000	NA	10.0	NA	10.00
38.8	2.42	2.42	0.77	1.65	1.65	5.00	1.20	28	0.369	0.943	1.000	0.95	0.330	0.862	0.070	0	0	0.000	#DIV/0!	#DIV/0!	5.0	5.02
43.8	2.73	2.73	0.93	1.81	1.81	5.00	1.20	22	0.239	0.945	1.000	0.95	0.214	0.816	0.068	0	0	0.000	#DIV/0!	#DIV/0!	3.3	3.34
48.8	3.05	3.05	1.08	1.96	1.96	5.00	1.20	35	NA	0.899	1.000	0.95	NA	0.765	0.066	0	0	0.000	NA	10.0	NA	10.00
53.8	3.36	3.36	1.24	2.12	2.12	5.00	1.20	25	0.297	0.920	1.000	0.95	0.259	0.715	0.063	0	0	0.000	#DIV/0!	#DIV/0!	4.4	4.39
58.8	3.67	3.67	1.40	2.28	2.28	5.00	1.20	14	0.152	0.936	1.000	0.95	0.135	0.670	0.060	0	0	0.000	#DIV/0!	#DIV/0!	2.4	2.40
63.8	3.98	3.98	1.55	2.43	2.43	5.00	1.20	11	0.126	0.937	1.000	0.95	0.112	0.631	0.057	0	0	0.000	#DIV/0!	#DIV/0!	2.1	2.08
68.8	4.30	4.30	1.71	2.59	2.59	5.00	1.20	15	0.162	0.923	1.000	0.95	0.142	0.599	0.055	0	0	0.000	#DIV/0!	#DIV/0!	2.7	2.74
73.8	4.61	4.61	1.86	2.75	2.75	5.00	1.20	21	0.234	0.902	1.000	0.95	0.200	0.573	0.053	0	0	0.000	#DIV/0!	#DIV/0!	4.0	3.99
78.8	4.92	4.92	2.02	2.90	2.90	5.00	1.20	62	NA	0.697	1.000	0.95	NA	0.553	0.052	0	0	0.000	NA	10.0	NA	10.00

Clifty Creek AEP, Boring = SI-1, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts

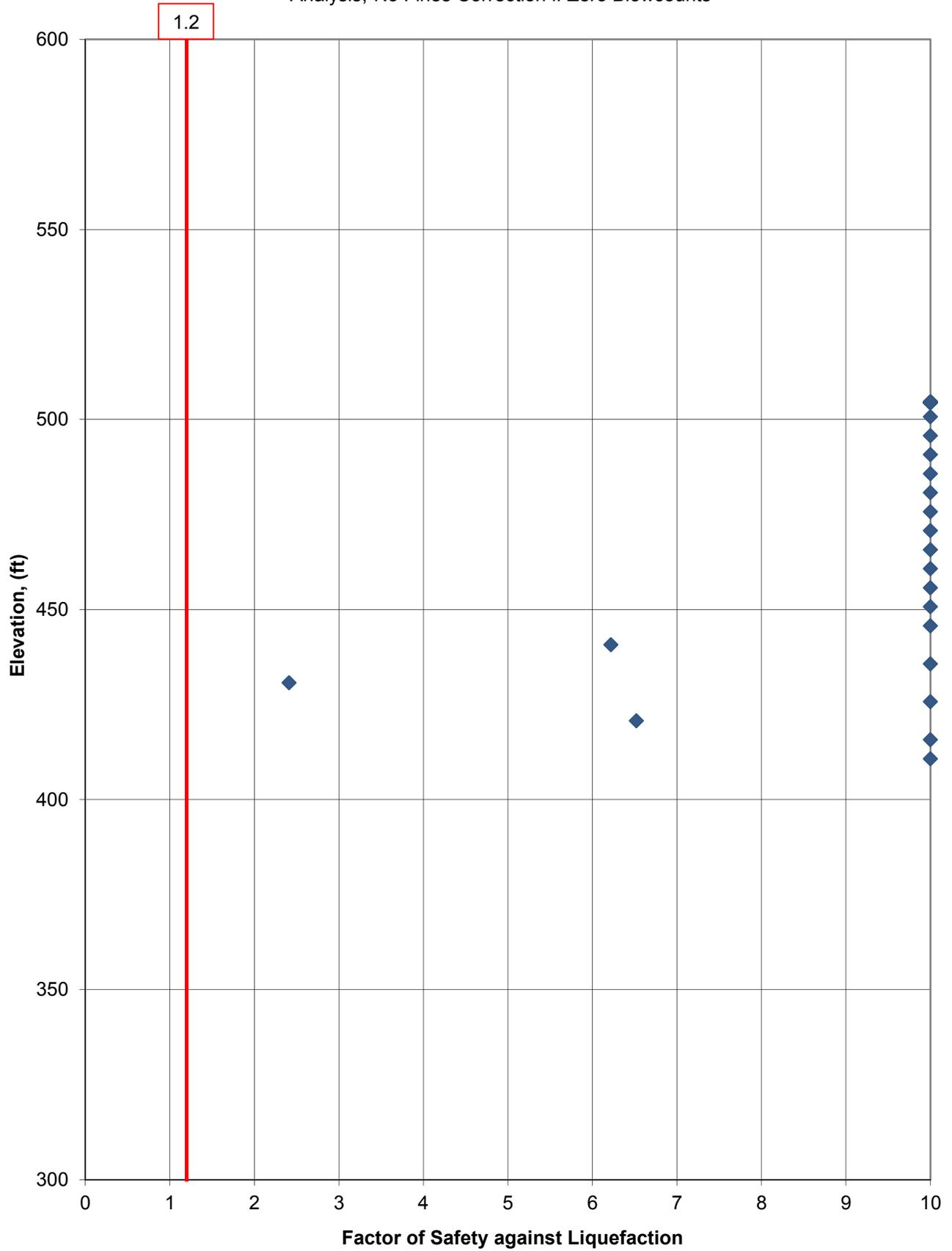


Clifty Creek AEP, Boring = SI-1, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts

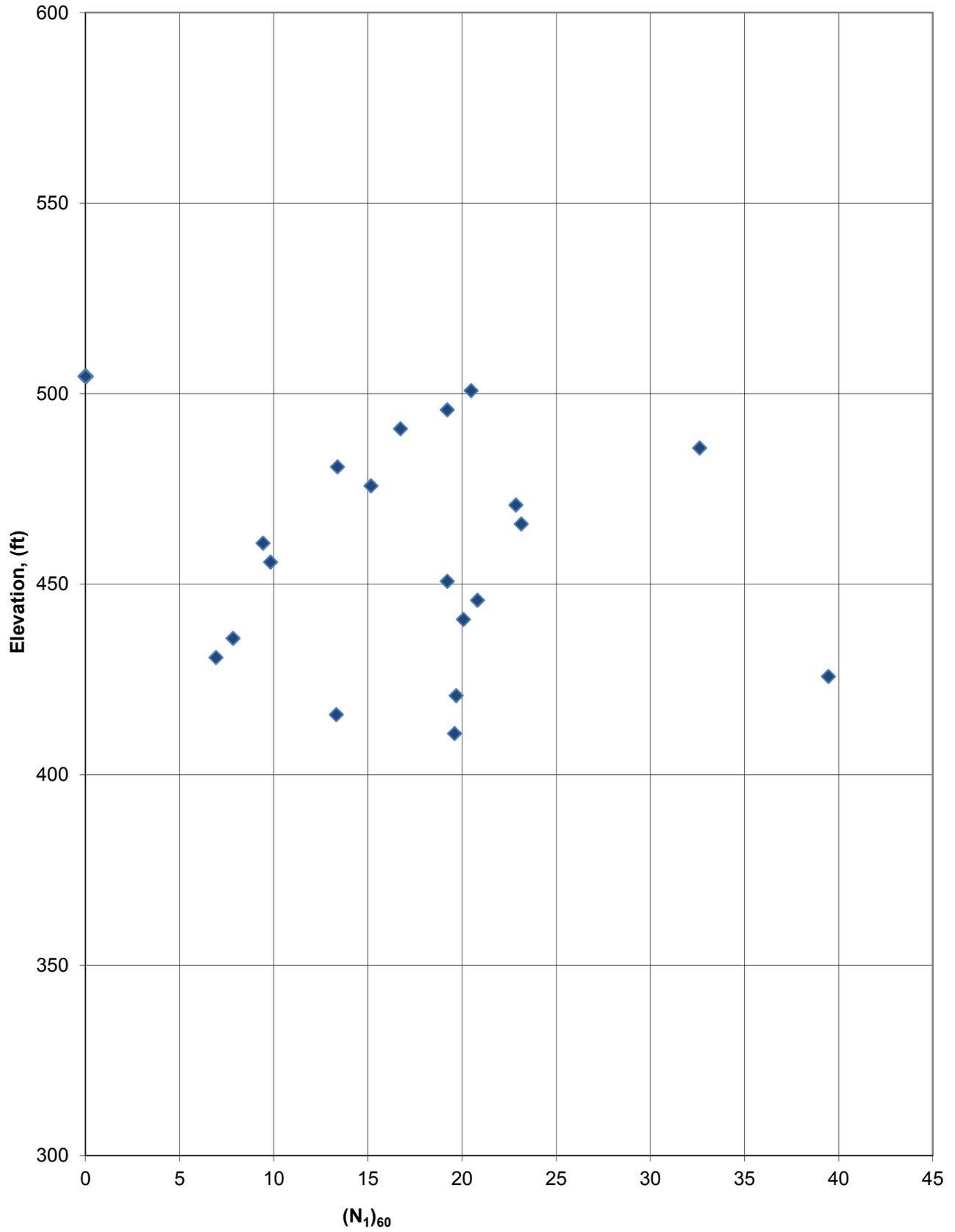


Depth of Mid. Pt. of Sample (ft.)	Vert. Total Stress during EQ (tsf)	Vert. Total Stress during EQ w/ Fill (tsf)	Static Pore Pressure during EQ (tsf)	Vert. Eff. Stress during EQ (tsf)	Vert. Eff. Stress during EQ w/ Fill (tsf)	Effective All-Around Stress during EQ (psf)	Shear Modulus during EQ (ksf)	Equivalent Clean Sand N-Value	Alpha I	Beta I	(N ₁) _{60cs}	CRR7.5	Ksigma	Kalpha	EQ Source		Event (MCE, OBE, etc.)		Shake Stress Curve Fit Parameters						
															a max (g)	EQ Motion File	m4:	m3:	m2:	m1:					
z	σ _v	σ _v with fill	u	σ _v	σ _v with fill	σ _m	G _{max}								Mag. Scaling	CRR	Simplified Stress Reduction Coeff., r _s	Simplified CSR eq Design EQ	Max. Shake Stress (psf) Design EQ	Avg. Shake Stress (psf) Design EQ	Using SHAKE Data			Simplified	
															Factor (Cm)	Design EQ					CSR eq Design EQ	FS liq Design EQ	FS liq for plot	FS liq Design EQ	FS liq for plot
Boring ID: SS2-1						Note: A factor of safety shown as "NA" implies that the soil type is not appropriately evaluated using this methodology. This applies to soils classified as CL, CH, CL-ML and MH. These soils should be evaluated using methods for fine-grained soils. Also, "NA" implies that coarse grained soils with equivalent clean sand N-values greater than 30 are resistant to liquefaction.																			
Top of Fill Elevation: 504.5 ft (if no fill, then set this equal to top of SPT hole elev.)																									
Fill Height: 0.0 ft (relative to ground surface during SPT)																									
Fill Total Unit Weight: 125 pcf																									
Fill Total Stress: 0.00 tsf																									
	tsfstr-top 0.19		u-top 0.00	effstr-top 0.19																					
3.8	0.23	0.23	0.00	0.23	0.23	312.50	#NUM!	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.993	0.055	0	0	0.000	NA	10.0	NA	10.00
8.8	0.55	0.55	0.00	0.55	0.55	729.17	#NUM!	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.982	0.054	0	0	0.000	NA	10.0	NA	10.00
13.8	0.86	0.86	0.12	0.74	0.74	989.83	#NUM!	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.971	0.062	0	0	0.000	NA	10.0	NA	10.00
18.8	1.17	1.17	0.27	0.90	0.90	1198.50	#NUM!	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.960	0.069	0	0	0.000	NA	10.0	NA	10.00
23.8	1.48	1.48	0.43	1.06	1.06	1407.17	#NUM!	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.946	0.074	0	0	0.000	NA	10.0	NA	10.00
28.8	1.80	1.80	0.59	1.21	1.21	1615.83	#NUM!	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.927	0.076	0	0	0.000	NA	10.0	NA	10.00
33.8	2.11	2.11	0.74	1.37	1.37	1824.50	#NUM!	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.899	0.077	0	0	0.000	NA	10.0	NA	10.00
38.8	2.42	2.42	0.90	1.52	1.52	2033.17	#NUM!	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.862	0.076	0	0	0.000	NA	10.0	NA	10.00
43.8	2.73	2.73	1.05	1.68	1.68	2241.83	#NUM!	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.816	0.073	0	0	0.000	NA	10.0	NA	10.00
48.8	3.05	3.05	1.21	1.84	1.84	2450.50	#NUM!	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.765	0.070	0	0	0.000	NA	10.0	NA	10.00
53.8	3.36	3.36	1.37	1.99	1.99	2659.17	#NUM!	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.715	0.067	0	0	0.000	NA	10.0	NA	10.00
58.8	3.67	3.67	1.52	2.15	2.15	2867.83	#NUM!	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.670	0.063	0	0	0.000	NA	10.0	NA	10.00
63.8	3.98	3.98	1.68	2.31	2.31	3076.50	#NUM!	5.00	1.20	29	0.414	0.896	1.000	0.95	0.352	0.631	0.060	0	0	0.000	#DIV/0!	#DIV/0!	6.2	6.22	
68.8	4.30	4.30	1.83	2.46	2.46	3285.17	#NUM!	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.599	0.058	0	0	0.000	NA	10.0	NA	10.00
73.8	4.61	4.61	1.99	2.62	2.62	3493.83	#NUM!	5.00	1.20	13	0.144	0.928	1.000	0.95	0.126	0.573	0.056	0	0	0.000	#DIV/0!	#DIV/0!	2.4	2.41	
78.8	4.92	4.92	2.15	2.78	2.78	3702.50	#NUM!	5.00	1.20	52	NA	0.711	1.000	0.95	NA	0.553	0.054	0	0	0.000	NA	10.0	NA	10.00	
83.8	5.23	5.23	2.30	2.93	2.93	3911.17	#NUM!	5.00	1.20	29	0.393	0.869	1.000	0.95	0.324	0.536	0.053	0	0	0.000	#DIV/0!	#DIV/0!	6.5	6.52	
88.8	5.55	5.55	2.46	3.09	3.09	4119.83	#NUM!	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.522	0.052	0	0	0.000	NA	10.0	NA	10.00
93.8	5.86	5.86	2.61	3.25	3.25	4328.50	#NUM!	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.511	0.051	0	0	0.000	NA	10.0	NA	10.00

Clifty Creek AEP, Boring = SS2-1, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts



Clifty Creek AEP, Boring = SS2-1, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts



EQ Source	0
a max (g)	0.085
EQ Mag (Mw)	7.7
Mag. Scaling	

Event (MCE, OBE, etc.)

0

EQ Motion File

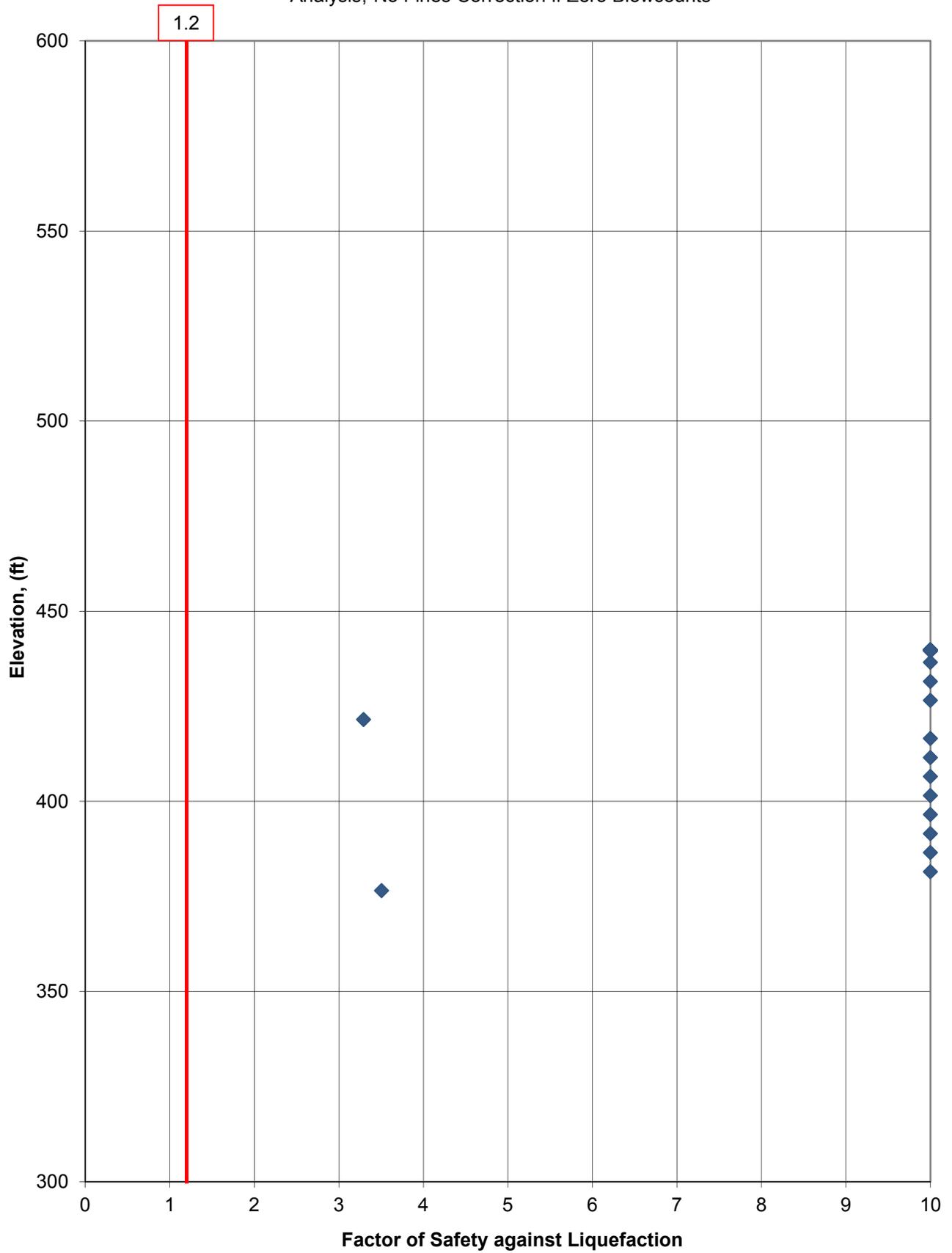
0

Shake Stress Curve Fit Parameters

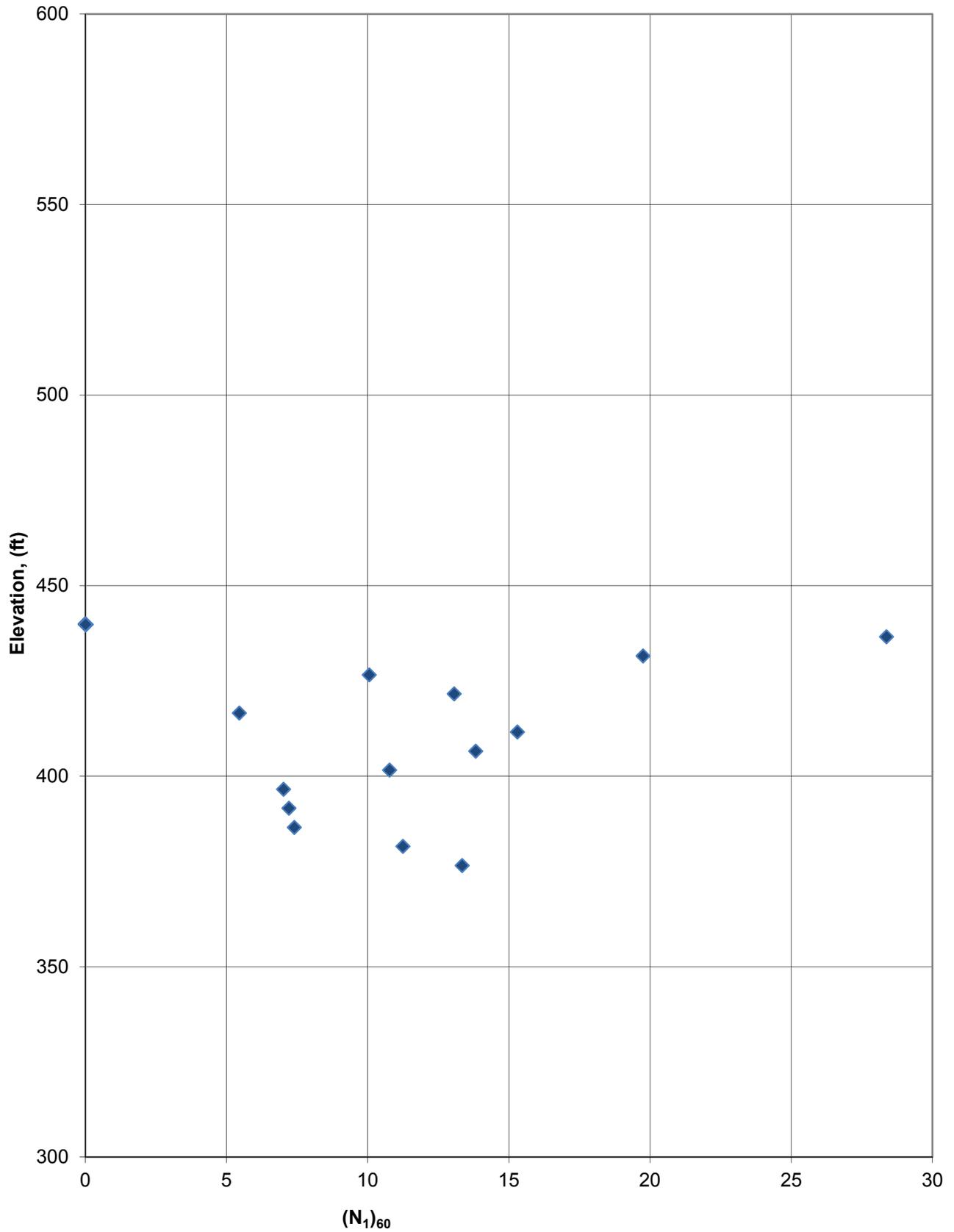
m4:	0
m3:	0
m2:	0
m1:	0

Depth of Mid. Pt. of Sample (ft.)	Vert. Total Stress during EQ (tsf)	Vert. Total Stress during EQ w/ Fill (tsf)	Static Pore Pressure during EQ (tsf)	Vert. Eff. Stress during EQ (tsf)	Vert. Eff. Stress during EQ w/ Fill (tsf)	Alpha I	Beta I	Equivalent Clean Sand N-Value (N1) ^{60CS}	CRR7.5	Ksigma	Kalpha	Factor (Cm)	Design EQ	Simplified Stress Reduction	Simplified CSR eq	Max. Shake Stress (psf)	Avg. Shake Stress (psf)	Using SHAKE Data			Simplified		
														Coeff., r_d	Design EQ			Design EQ	Design EQ	Design EQ	FS liq	FS liq	FS liq	FS liq
z	σ_v	$\sigma_{v\text{ with fill}}$	u	σ'_v	$\sigma'_{v\text{ with fill}}$													Design EQ	Design EQ	Design EQ	Design EQ	Design EQ	Design EQ
Boring ID: SS2-4 Top of Fill Elevation: 439.8 Fill Height: 0.0 Fill Total Unit Weight: 125 Fill Total Stress: 0.00						Note: A factor of safety shown as "NA" implies that the soil type is not appropriately evaluated using this methodology. This applies to soils classified as CL, CH, CL-ML and MH. These soils should be evaluated using methods for fine-grained soils. Also, "NA" implies that coarse grained soils with equivalent clean sand N-values greater than 30 are resistant to liquefaction.																	
	tolstr-top 0.16		u-top 0.00	effstr-top 0.16																			
3.3	0.20	0.20	0.00	0.20	0.20	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.994	0.055	0	0	0.000	NA	10.0	NA	10.00
8.3	0.52	0.52	0.00	0.52	0.52	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.983	0.054	0	0	0.000	NA	10.0	NA	10.00
13.3	0.83	0.83	0.10	0.73	0.73	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.972	0.061	0	0	0.000	NA	10.0	NA	10.00
18.3	1.14	1.14	0.26	0.88	0.88	5.00	1.20	21	0.224	1.000	1.000	1.000	0.95	0.212	0.961	0.069	0	0	0.000	#DIV/0!	#DIV/0!	3.3	3.29
23.3	1.45	1.45	0.41	1.04	1.04	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.948	0.073	0	0	0.000	NA	10.0	NA	10.00
28.3	1.77	1.77	0.57	1.20	1.20	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.929	0.076	0	0	0.000	NA	10.0	NA	10.00
33.3	2.08	2.08	0.73	1.35	1.35	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.902	0.077	0	0	0.000	NA	10.0	NA	10.00
38.3	2.39	2.39	0.88	1.51	1.51	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.866	0.076	0	0	0.000	NA	10.0	NA	10.00
43.3	2.70	2.70	1.04	1.67	1.67	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.821	0.074	0	0	0.000	NA	10.0	NA	10.00
48.3	3.02	3.02	1.19	1.82	1.82	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.771	0.070	0	0	0.000	NA	10.0	NA	10.00
53.3	3.33	3.33	1.35	1.98	1.98	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.720	0.067	0	0	0.000	NA	10.0	NA	10.00
58.3	3.64	3.64	1.51	2.14	2.14	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.674	0.063	0	0	0.000	NA	10.0	NA	10.00
63.3	3.95	3.95	1.66	2.29	2.29	5.00	1.20	21	0.228	0.920	1.000	1.000	0.95	0.199	0.634	0.060	0	0	0.000	#DIV/0!	#DIV/0!	3.5	3.50

Clifty Creek AEP, Boring = SS2-4, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts

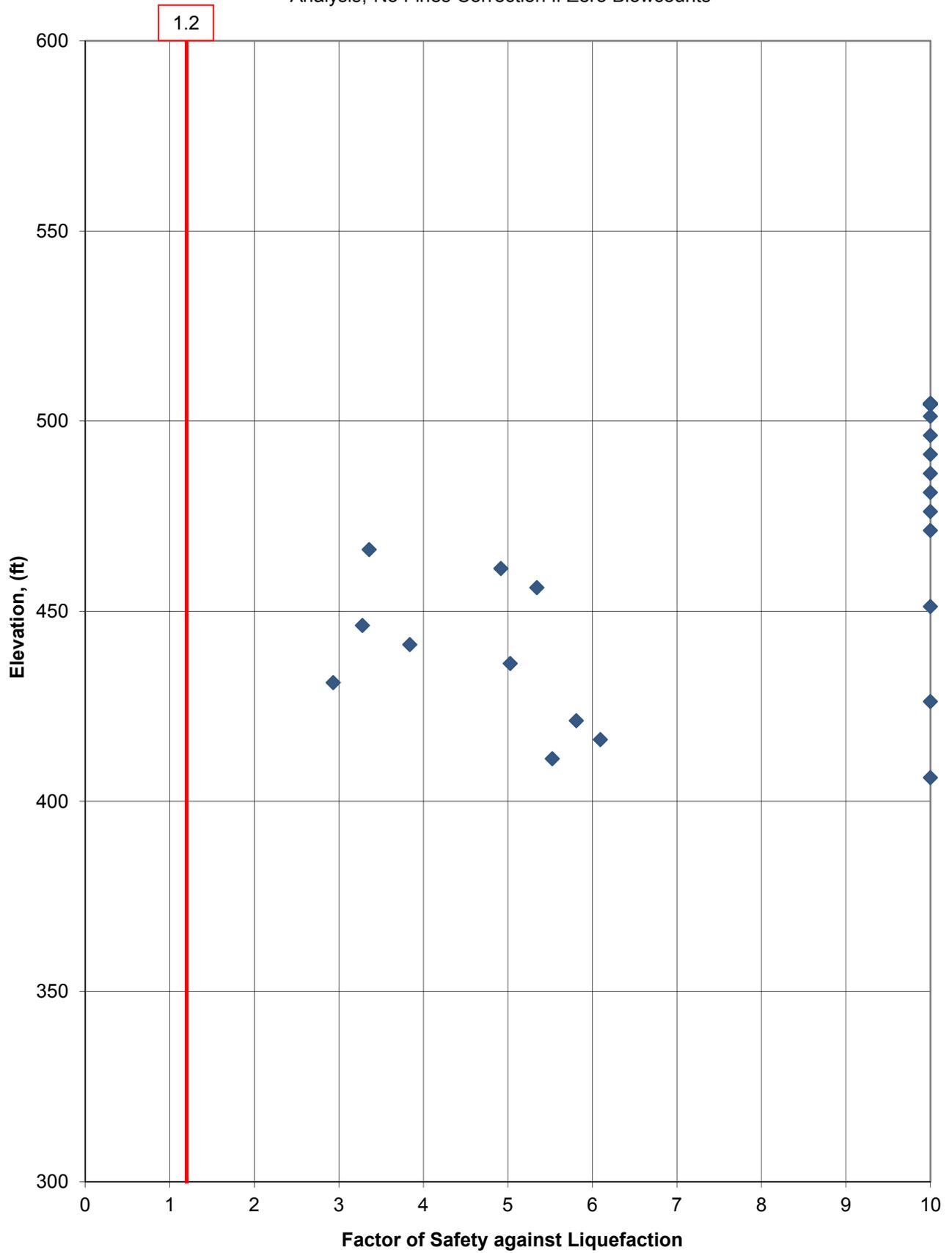


Clifty Creek AEP, Boring = SS2-4, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts

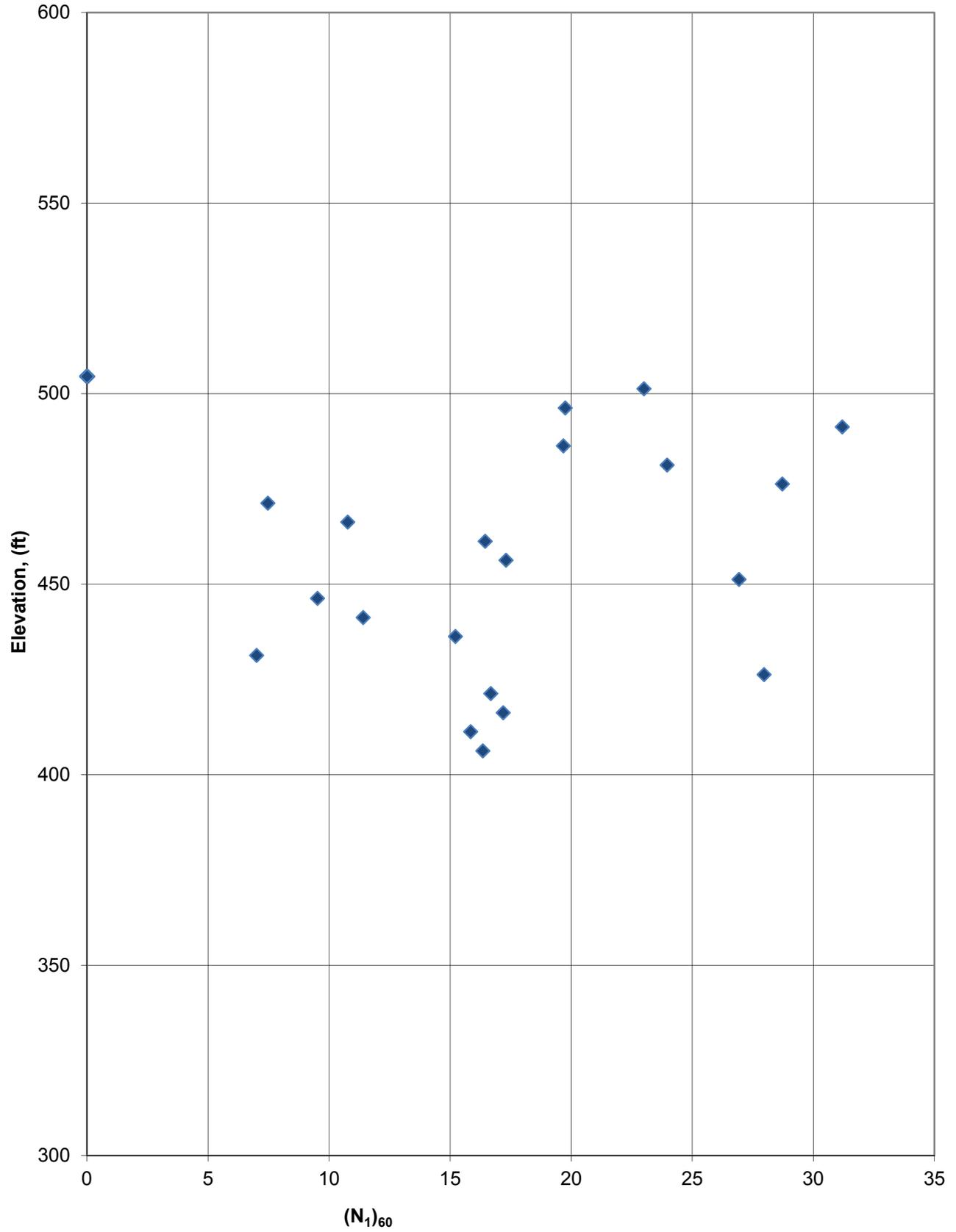


Depth of Mid. Pt. of Sample (ft.)	Vert. Total Stress during EQ (tsf)	Vert. Total Stress during EQ w/ Fill (tsf)	Static Pore Pressure during EQ (tsf)	Vert. Eff. Stress during EQ (tsf)	Vert. Eff. Stress during EQ w/ Fill (tsf)	Effective All-Around Stress during EQ (psf)	Shear Modulus during EQ (ksf)	Equivalent Clean Sand N-Value	Alpha I	Beta I	(N ₁) _{60cs}	CRR7.5	Ksigma	Kalpha	EQ Source		Event (MCE, OBE, etc.)		Shake Stress Curve Fit Parameters							
															0	0	0	0	0	0	0	0				
z	σ _v	σ _v with fill	u	σ _v	σ _v with fill	σ _m	G _{max}								Mag. Scaling	CRR	Simplified Stress Reduction	Simplified CSR eq	EQ Motion File	Max. Shake Stress (psf)	Avg. Shake Stress (psf)	Using SHAKE Data		Simplified		
															Factor (Cm)	Design EQ	Coeff., r _d	Design EQ	0	Design EQ	Design EQ	CSR eq	FS liq	FS liq	FS liq	FS liq
Boring ID: SS3-1 Top of Fill Elevation: 504.5 ft (if no fill, then set this equal to top of SPT hole elev.) Fill Height: 0.0 ft (relative to ground surface during SPT) Fill Total Unit Weight: 125 pcf Fill Total Stress: 0.00 tsf						Note: A factor of safety shown as "NA" implies that the soil type is not appropriately evaluated using this methodology. This applies to soils classified as CL, CH, CL-ML and MH. These soils should be evaluated using methods for fine-grained soils. Also, "NA" implies that coarse grained soils with equivalent clean sand N-values greater than 30 are resistant to liquefaction.																				
	tsfstr-top 0.16		u-top 0.00	effstr-top 0.16																						
3.3	0.20	0.20	0.00	0.20	0.20	270.83	#NUM!	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.994	0.055	0	0	0.000	NA	10.0	NA	10.00	
8.3	0.52	0.52	0.00	0.52	0.52	687.50	#NUM!	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.983	0.054	0	0	0.000	NA	10.0	NA	10.00	
13.3	0.83	0.83	0.00	0.83	0.83	1104.17	#NUM!	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.972	0.054	0	0	0.000	NA	10.0	NA	10.00	
18.3	1.14	1.14	0.00	1.14	1.14	1520.83	#NUM!	5.00	1.20	29	NA	0.990	1.000	0.95	NA	0.961	0.053	0	0	0.000	NA	10.0	NA	10.00		
23.3	1.45	1.45	0.00	1.45	1.45	1937.50	#NUM!	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.948	0.052	0	0	0.000	NA	10.0	NA	10.00	
28.3	1.77	1.77	0.00	1.77	1.77	2354.17	#NUM!	5.00	1.20	39	NA	0.909	1.000	0.95	NA	0.929	0.051	0	0	0.000	NA	10.0	NA	10.00		
33.3	2.08	2.08	0.10	1.98	1.98	2635.63	#NUM!	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.902	0.052	0	0	0.000	NA	10.0	NA	10.00	
38.3	2.39	2.39	0.26	2.13	2.13	2844.30	#NUM!	5.00	1.20	18	0.191	0.935	1.000	0.95	0.169	0.866	0.054	0	0	0.000	#DIV/0!	#DIV/0!	3.4	3.36		
43.3	2.70	2.70	0.41	2.29	2.29	3052.97	#NUM!	5.00	1.20	25	0.287	0.911	1.000	0.95	0.248	0.821	0.054	0	0	0.000	#DIV/0!	#DIV/0!	4.9	4.92		
48.3	3.02	3.02	0.57	2.45	2.45	3261.63	#NUM!	5.00	1.20	26	0.308	0.904	1.000	0.95	0.264	0.771	0.052	0	0	0.000	#DIV/0!	#DIV/0!	5.3	5.34		
53.3	3.33	3.33	0.73	2.60	2.60	3470.30	#NUM!	5.00	1.20	37	NA	0.847	1.000	0.95	NA	0.720	0.051	0	0	0.000	NA	10.0	NA	10.00		
58.3	3.64	3.64	0.88	2.76	2.76	3678.97	#NUM!	5.00	1.20	16	0.175	0.915	1.000	0.95	0.152	0.674	0.049	0	0	0.000	#DIV/0!	#DIV/0!	3.3	3.28		
63.3	3.95	3.95	1.04	2.92	2.92	3887.63	#NUM!	5.00	1.20	19	0.200	0.906	1.000	0.95	0.172	0.634	0.048	0	0	0.000	#DIV/0!	#DIV/0!	3.8	3.84		
68.3	4.27	4.27	1.19	3.07	3.07	4096.30	#NUM!	5.00	1.20	23	0.261	0.882	1.000	0.95	0.218	0.602	0.046	0	0	0.000	#DIV/0!	#DIV/0!	5.0	5.03		
73.3	4.58	4.58	1.35	3.23	3.23	4304.97	#NUM!	5.00	1.20	13	0.144	0.908	1.000	0.95	0.124	0.576	0.045	0	0	0.000	#DIV/0!	#DIV/0!	2.9	2.93		
78.3	4.89	4.89	1.51	3.39	3.39	4513.63	#NUM!	5.00	1.20	39	NA	0.794	1.000	0.95	NA	0.555	0.044	0	0	0.000	NA	10.0	NA	10.00		
83.3	5.20	5.20	1.66	3.54	3.54	4722.30	#NUM!	5.00	1.20	25	0.292	0.861	1.000	0.95	0.239	0.538	0.044	0	0	0.000	#DIV/0!	#DIV/0!	5.8	5.81		
88.3	5.52	5.52	1.82	3.70	3.70	4930.97	#NUM!	5.00	1.20	26	0.305	0.856	1.000	0.95	0.247	0.524	0.043	0	0	0.000	#DIV/0!	#DIV/0!	6.1	6.09		
93.3	5.83	5.83	1.97	3.85	3.85	5139.63	#NUM!	5.00	1.20	24	0.274	0.857	1.000	0.95	0.222	0.512	0.043	0	0	0.000	#DIV/0!	#DIV/0!	5.5	5.53		
98.3	6.14	6.14	2.13	4.01	4.01	5348.30	#NUM!	NA	NA	NA	NA	NA	NA	NA	0.95	NA	0.502	0.042	0	0	0.000	NA	10.0	NA	10.00	

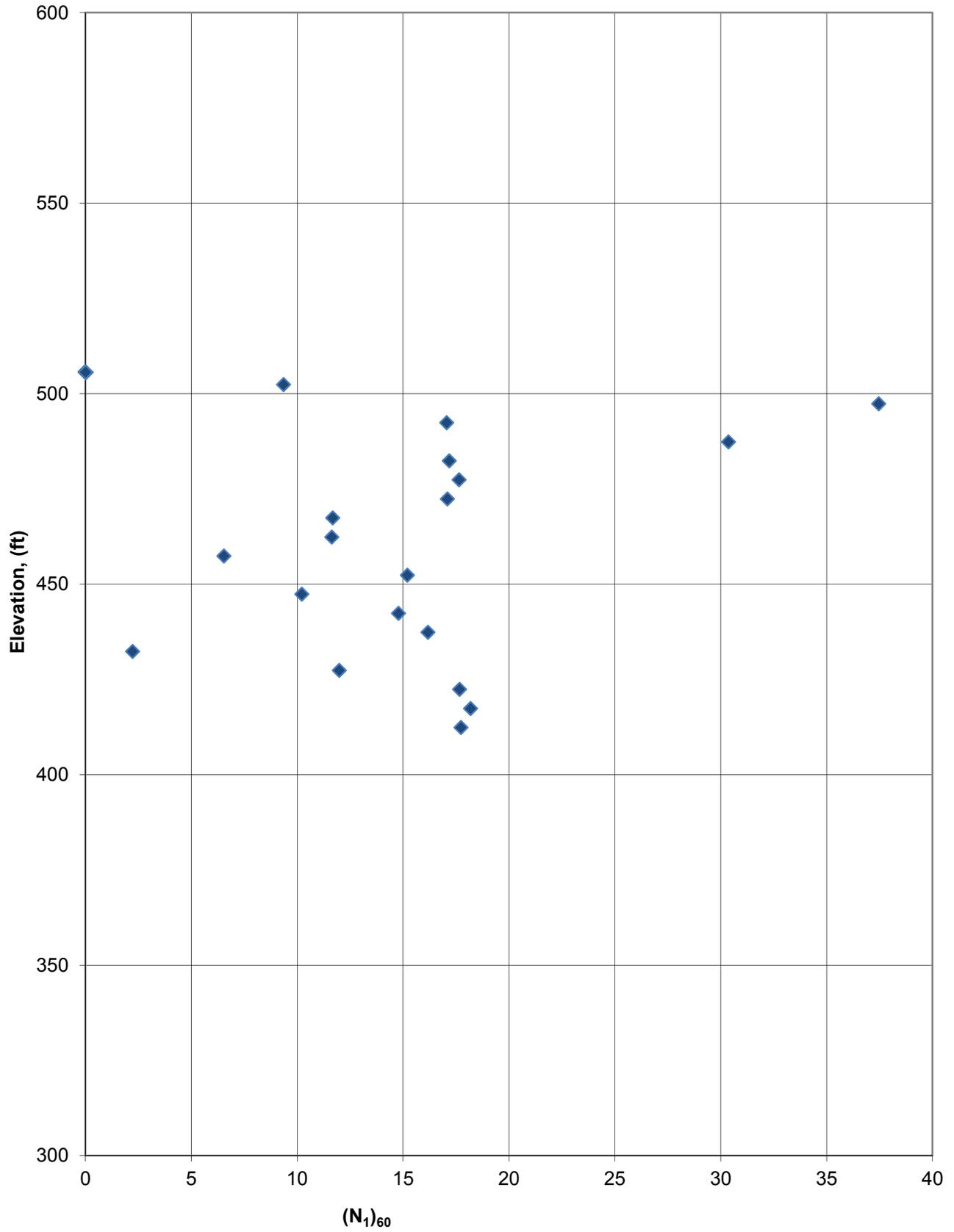
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NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts



Clifty Creek AEP, Boring = SS3-1, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts



Clifty Creek AEP, Boring = SS4-1, Source = 0, Mw = 7.7, Event = 0, SPT Data,
NCEER Method (updated per Idriss and Boulanger (2008)) with Ground Response
Analysis, No Fines Correction if Zero Blowcounts



APPENDIX I

STABILITY ANALYSIS

BOILER SLAG POND DAM: 2015 CCR MANDATE

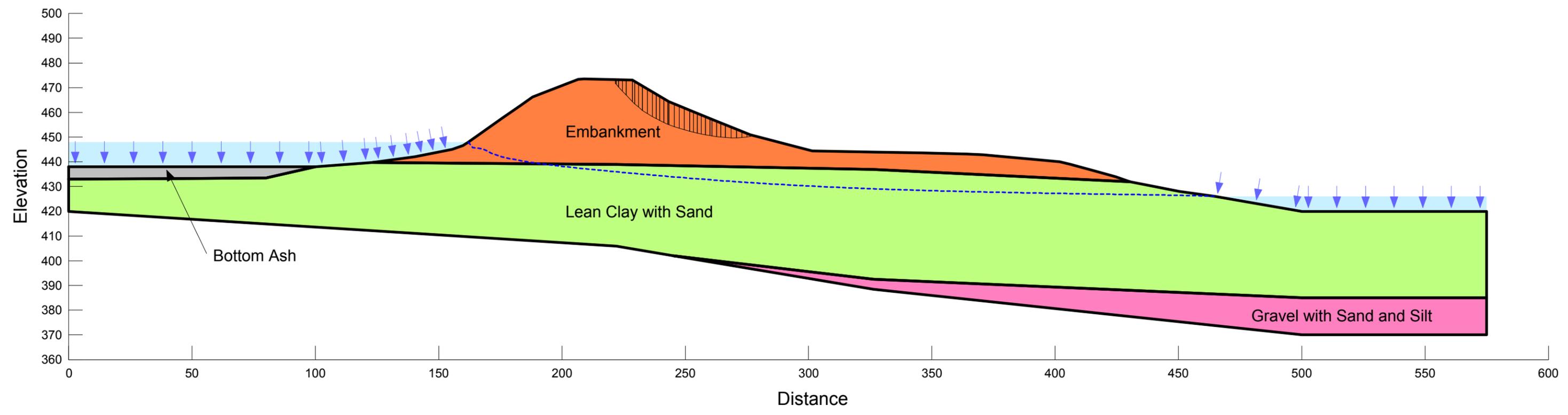
Factor of Safety = 2.30

**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate**

L01_Normal Pool, Downstream Slope Failure
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section A-A'

Material	Unit Weight (pcf)	Drained Strength Parameters	
		Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay with Sand (Drained)	119	27.2	160
Gravel With Silt and Sand (Drained)	130	35	0
Bottom Ash (Drained)	115	28	0

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.



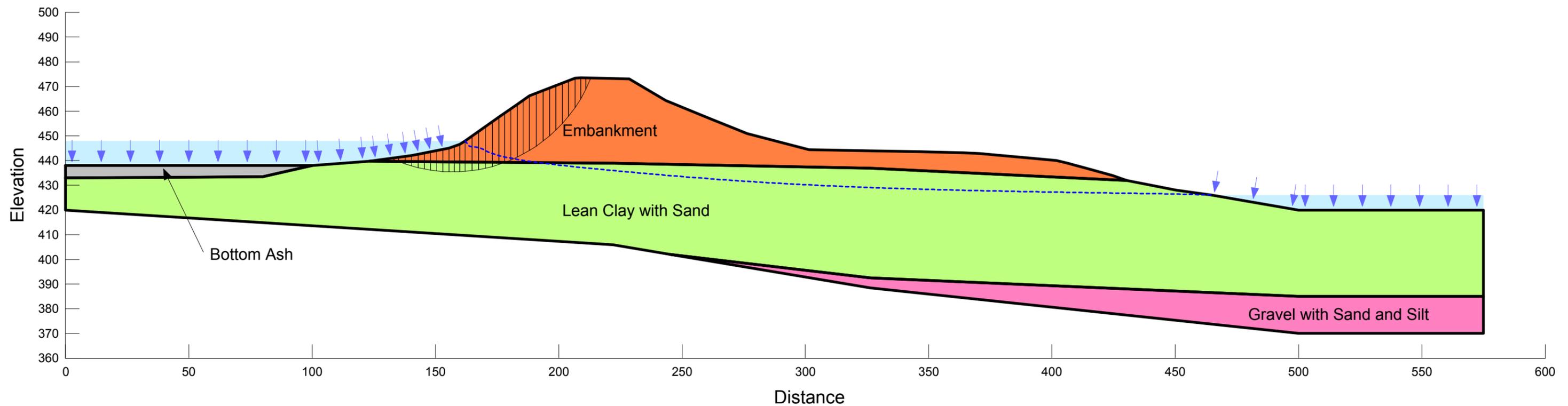
Factor of Safety = 1.88

**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate**

L02_Normal Pool, Upstream Slope Failure
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Incipient Motion in the Upstream Direction
Section A-A'

Material	Unit Weight (pcf)	Drained Strength Parameters	
		Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay with Sand (Drained)	119	27.2	160
Gravel With Silt and Sand (Drained)	130	35	0
Bottom Ash (Drained)	115	28	0

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.



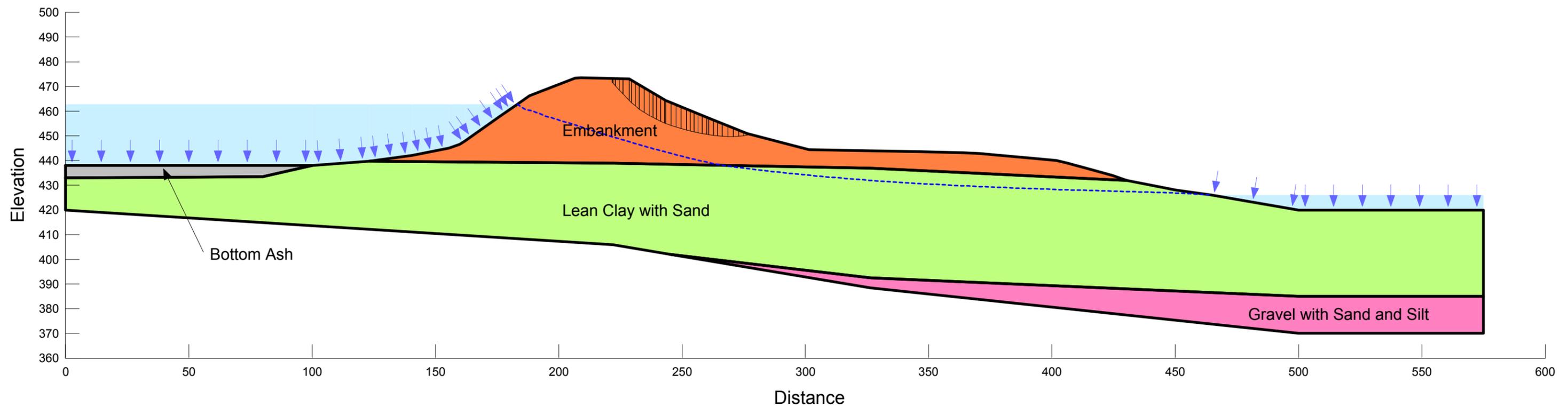
Factor of Safety = 2.30

**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate**

L03_50% PMF Pool, Downstream Slope Failure
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section A-A'

Material	Unit Weight (pcf)	Drained Strength Parameters	
		Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay with Sand (Drained)	119	27.2	160
Gravel With Silt and Sand (Drained)	130	35	0
Bottom Ash (Drained)	115	28	0

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.



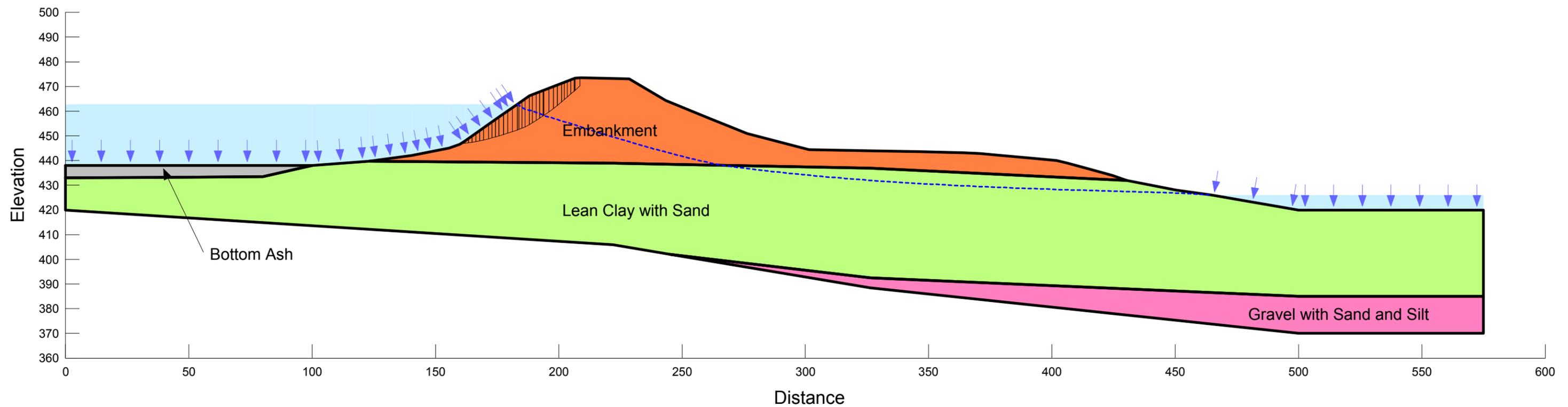
Factor of Safety = 2.13

**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate**

L04_50% PMF Pool, Upstream Slope Failure
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Incipient Motion in the Upstream Direction
Section A-A'

Material	Unit Weight (pcf)	Drained Strength Parameters	
		Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay with Sand (Drained)	119	27.2	160
Gravel With Silt and Sand (Drained)	130	35	0
Bottom Ash (Drained)	115	28	0

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.



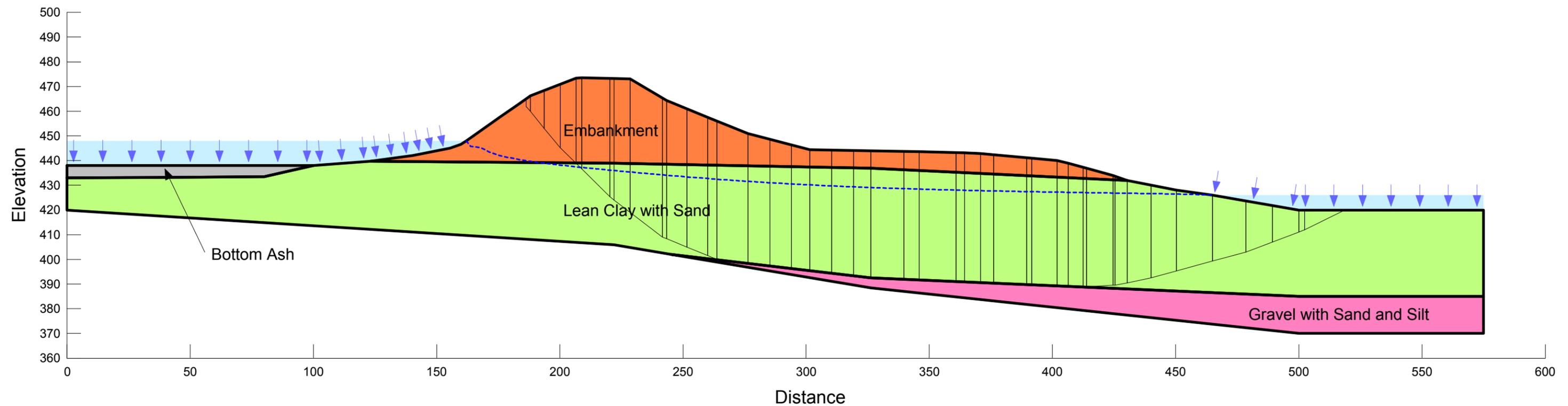
Factor of Safety = 1.35

**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate**

L05_Seismic_Normal Pool, Downstream Slope Failure
Normal Pool Elevation: 448 Feet
Undrained Static Strengths
Incipient Motion in the Downstream Direction
Horizontal Acc: 0.085g
Section A-A'

Material	Unit Weight (pcf)	Drained Strength Parameters		Undrained Strength Parameters	
		Phi (deg.)	Cohesion (psf)	Phi (deg.)	Cohesion (psf)
Embankment (Seismic Undrained)	130	33.2	165	13	600
Lean Clay with Sand (Seismic Undrained)	119	27.2	160	5	1200
Gravel With Silt and Sand (Seismic Undrained)	130	35	0	35	0
Bottom Ash (Seismic Undrained)	115	28	0	28	0

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.



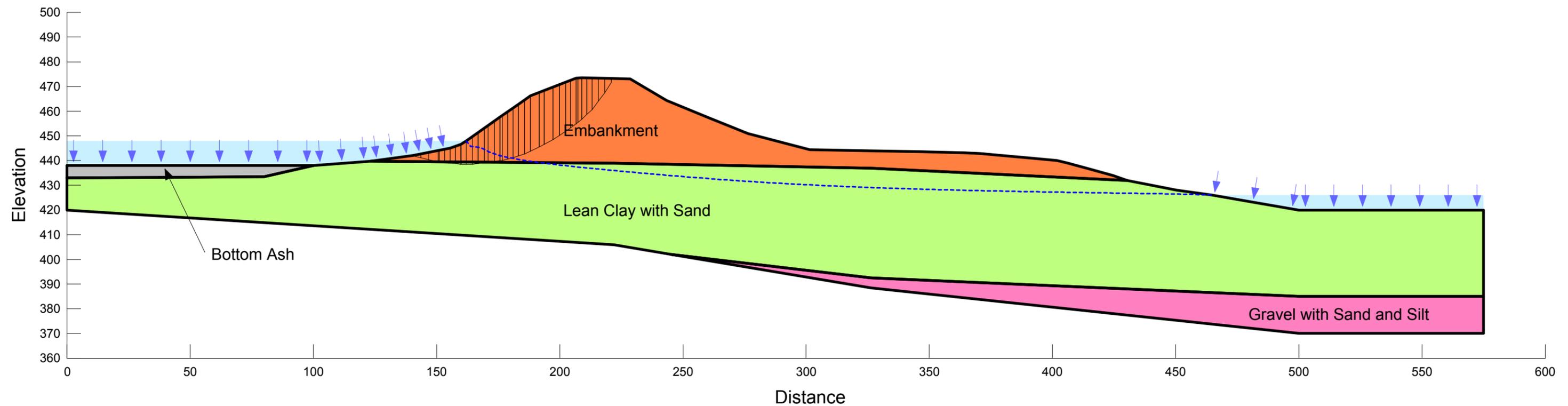
Factor of Safety = 1.34

**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate**

L06_Seismic_Normal Pool, Upstream Slope Failure
Normal Pool Elevation: 448 Feet
Undrained Static Strengths
Incipient Motion in the Upstream Direction
Horizontal Acc: 0.085g
Section A-A'

Material	Unit Weight (pcf)	Drained Strength Parameters		Undrained Strength Parameters	
		Phi (deg.)	Cohesion (psf)	Phi (deg.)	Cohesion (psf)
Embankment (Seismic Undrained)	130	33.2	165	13	600
Lean Clay with Sand (Seismic Undrained)	119	27.2	160	5	1200
Gravel With Silt and Sand (Seismic Undrained)	130	35	0	35	0
Bottom Ash (Seismic Undrained)	115	28	0	28	0

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.



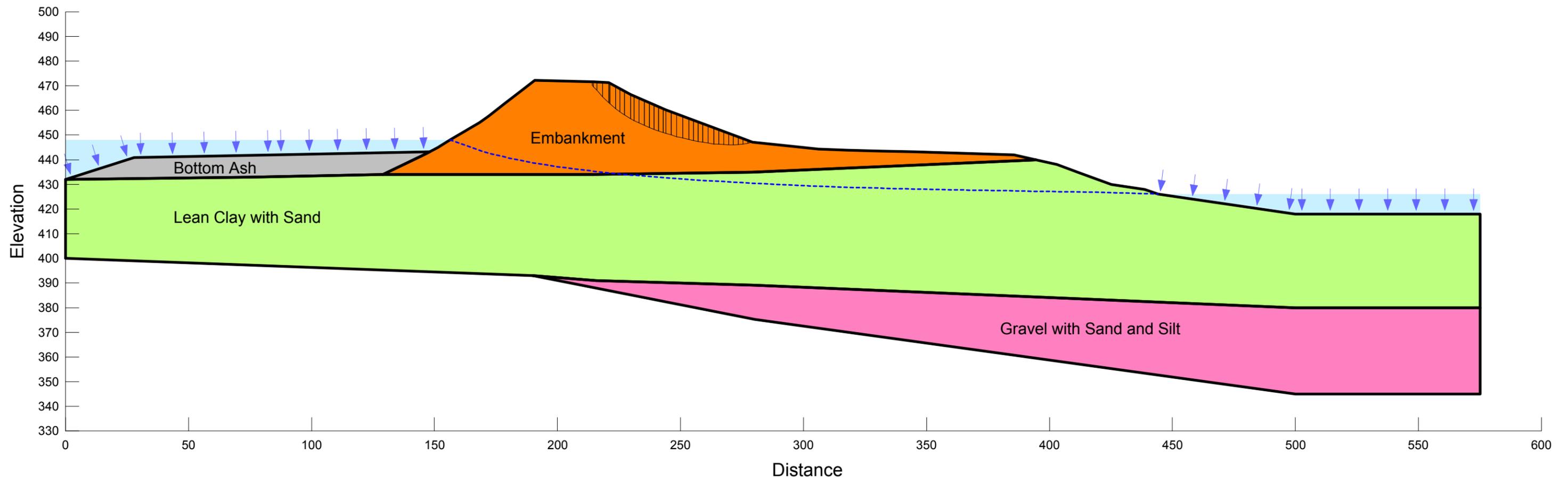
Factor of Safety = 2.44

**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate**

L01_Normal Pool, Downstream Slope Failure
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section B-B'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Drained Strength Parameters	
		Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay With Sand (Drained)	119	27.2	160
Gravel With Silt And Sand (Drained)	130	35	0
Bottom Ash (Drained)	115	28	0



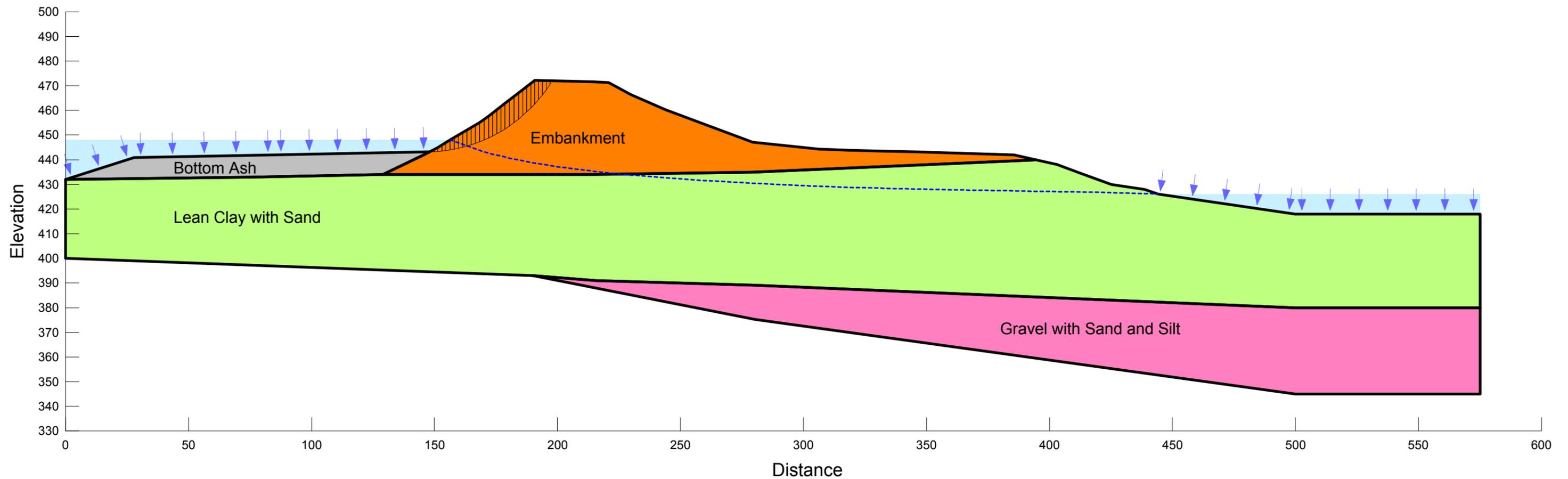
Factor of Safety = 1.63

**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate**

L02_Normal Pool, Upstream Slope Failure
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Incipient Motion in the Upstream Direction
Section B-B'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Drained Strength Parameters	
		Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay With Sand (Drained)	119	27.2	160
Gravel With Silt And Sand (Drained)	130	35	0
Bottom Ash (Drained)	115	28	0



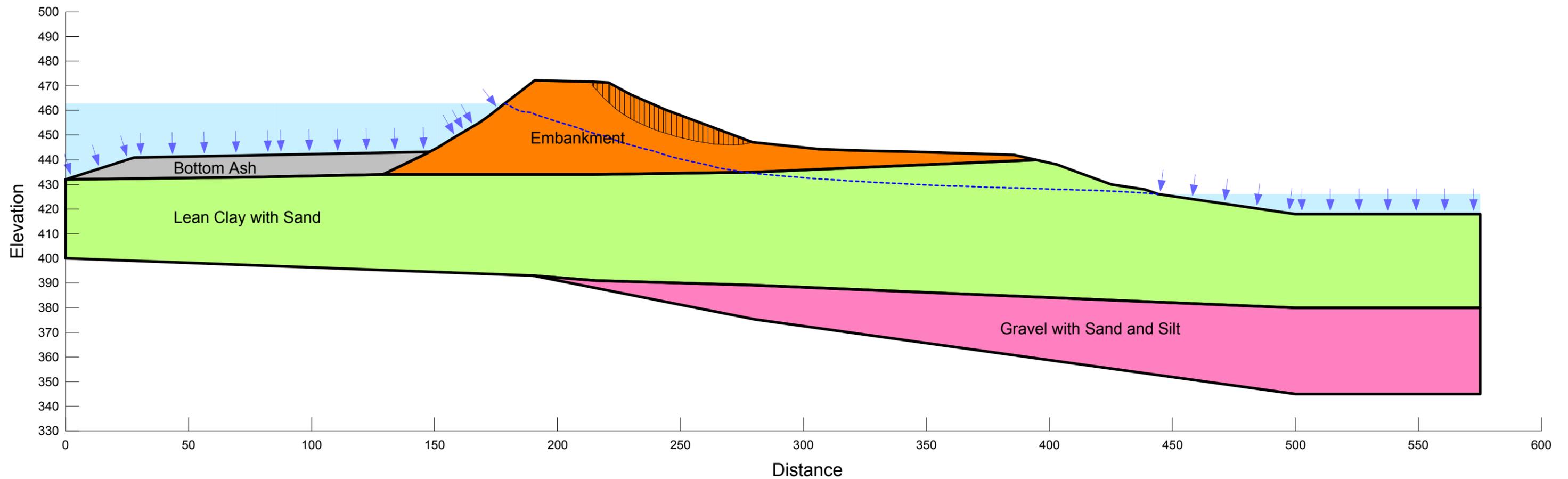
Factor of Safety = 2.44

**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate**

L03_50% PMF Pool, Downstream Slope Failure
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section B-B'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Drained Strength Parameters	
		Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay With Sand (Drained)	119	27.2	160
Gravel With Silt And Sand (Drained)	130	35	0
Bottom Ash (Drained)	115	28	0



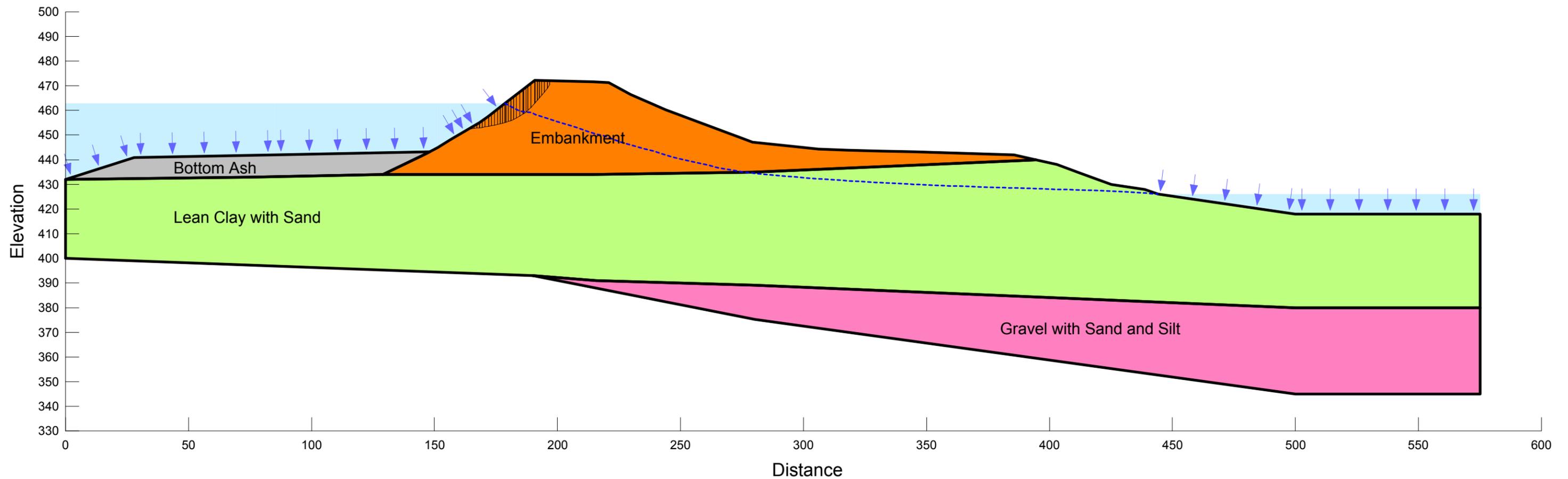
Factor of Safety = 1.95

**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate**

L04_50% PMF Pool, Upstream Slope Failure
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Incipient Motion in the Upstream Direction
Section B-B'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Drained Strength Parameters	
		Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay With Sand (Drained)	119	27.2	160
Gravel With Silt And Sand (Drained)	130	35	0
Bottom Ash (Drained)	115	28	0



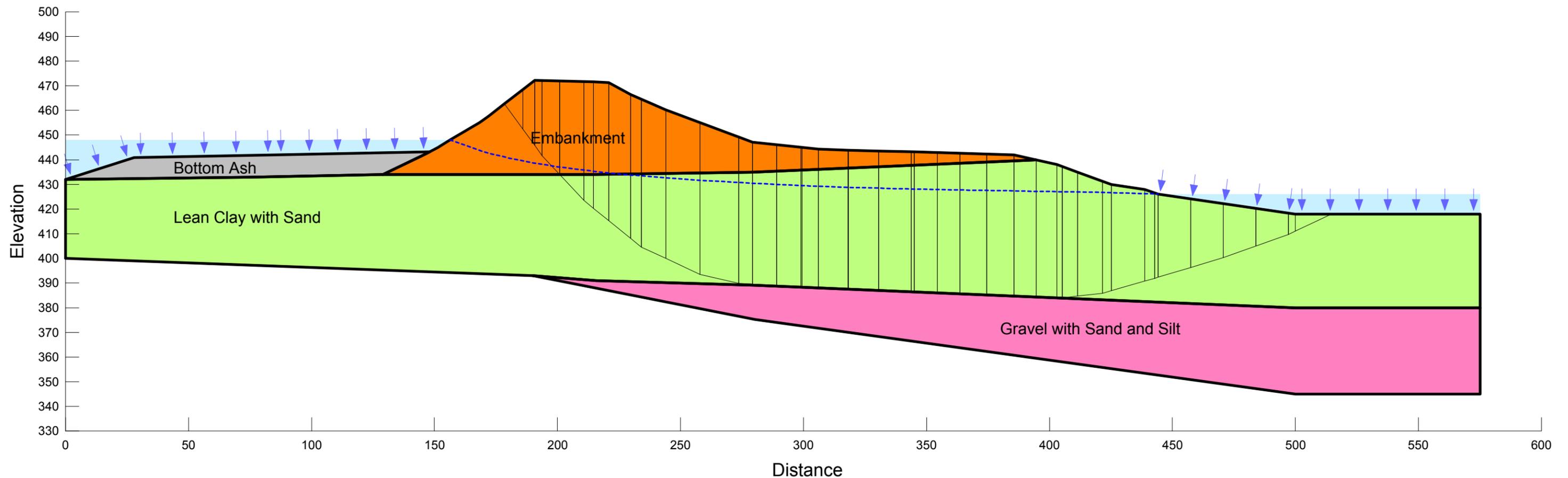
**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate**

Factor of Safety = 1.30

L05_Seismic_Normal Pool, Downstream Slope Failure
Normal Pool Elevation: 448 Feet
Undrained Static Strengths
Incipient Motion in the Downstream Direction
Horizontal Acc: 0.085g
Section B-B'

Material	Unit Weight (pcf)	Drained Strength Parameters		Undrained Strength Parameters	
		Phi (deg.)	Cohesion (psf)	Phi (deg.)	Cohesion (psf)
Embankment (Seismic Undrained)	130	33.2	165	13	600
Lean Clay With Sand (Seismic Undrained)	119	27.2	160	5	1200
Gravel With Silt And Sand (Seismic Undrained)	130	35	0	35	0
Bottom Ash (Seismic Undrained)	115	28	0	28	0

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.



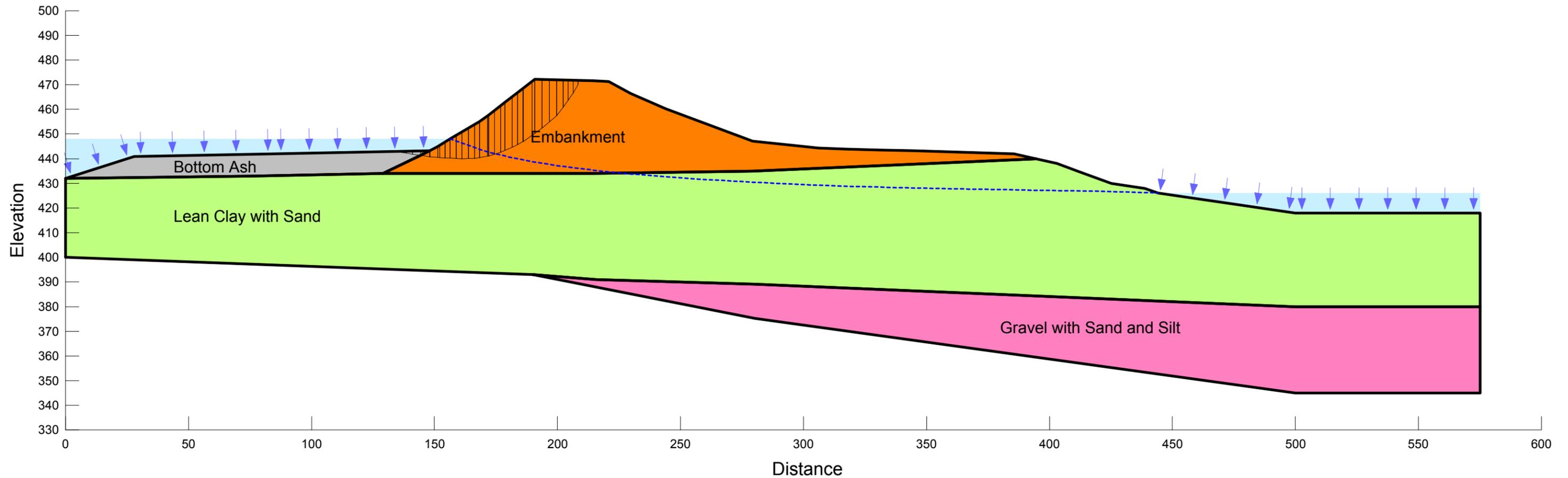
**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate**

Factor of Safety = 1.30

L06_Seismic_Normal Pool, Upstream Slope Failure
Normal Pool Elevation: 448 Feet
Undrained Static Strengths
Incipient Motion in the Upstream Direction
Horizontal Acc: 0.085g
Section B-B'

Material	Unit Weight (pcf)	Drained Strength Parameters		Undrained Strength Parameters	
		Phi (deg.)	Cohesion (psf)	Phi (deg.)	Cohesion (psf)
Embankment (Seismic Undrained)	130	33.2	165	13	600
Lean Clay With Sand (Seismic Undrained)	119	27.2	160	5	1200
Gravel With Silt And Sand (Seismic Undrained)	130	35	0	35	0
Bottom Ash (Seismic Undrained)	115	28	0	28	0

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.



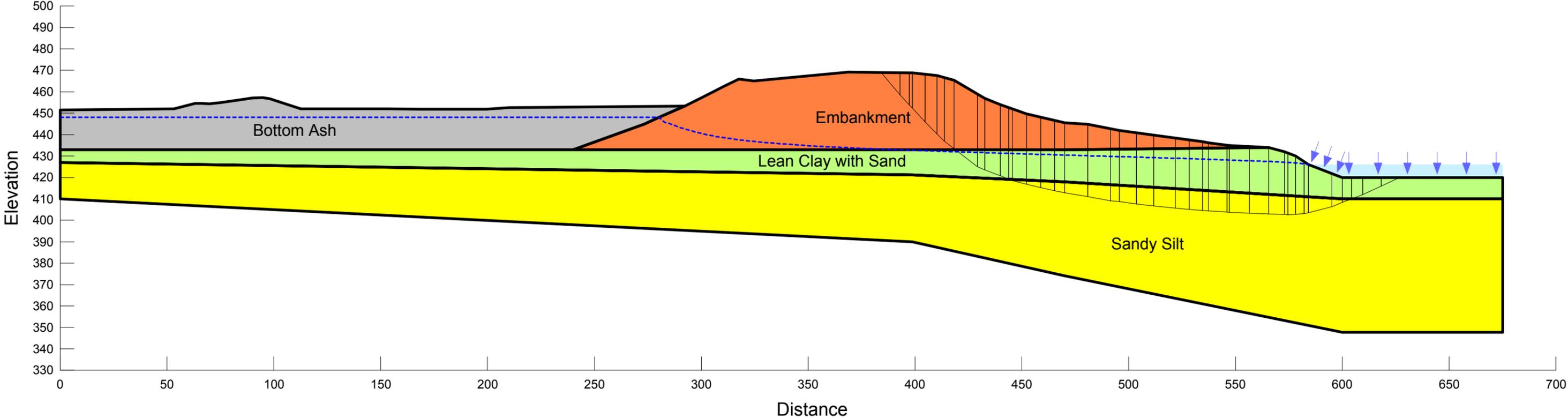
**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate**

Factor of Safety = 2.30

L01_Normal Pool, Downstream Slope Failure
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section C-C'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Drained Strength Parameters	
		Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay with Sand (Drained)	119	27.2	160
Sandy Silt (Drained)	130	30	0
Bottom Ash (Drained)	115	28	0



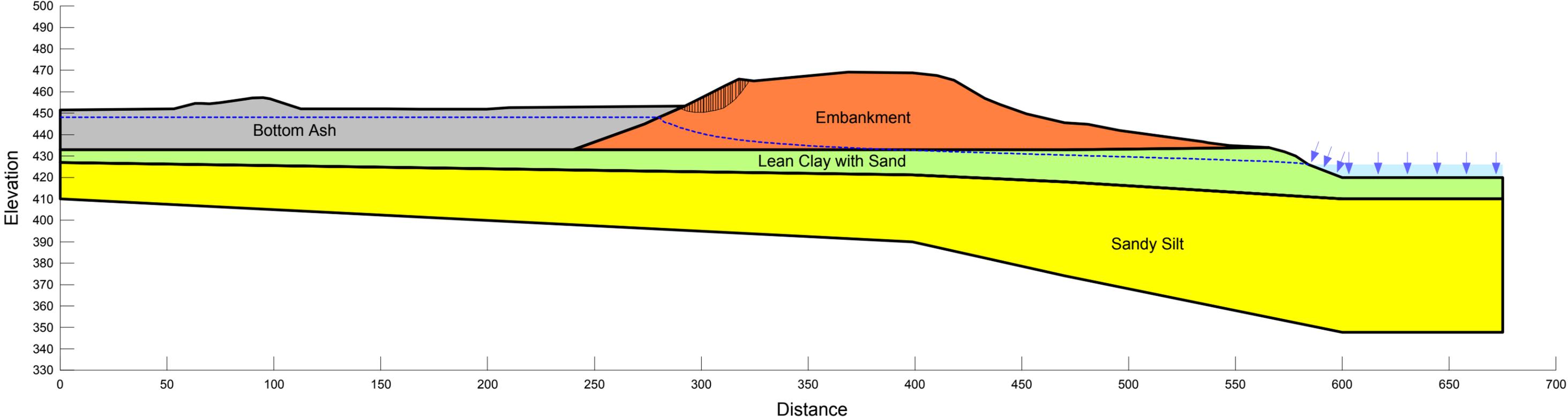
**American Electric Power (AEP)
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Madison, Indiana
CCR Mandate**

Factor of Safety = 2.73

L02_Normal Pool, Upstream Slope Failure
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Incipient Motion in the Upstream Direction
Section C-C'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Drained Strength Parameters	
		Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay with Sand (Drained)	119	27.2	160
Sandy Silt (Drained)	130	30	0
Bottom Ash (Drained)	115	28	0



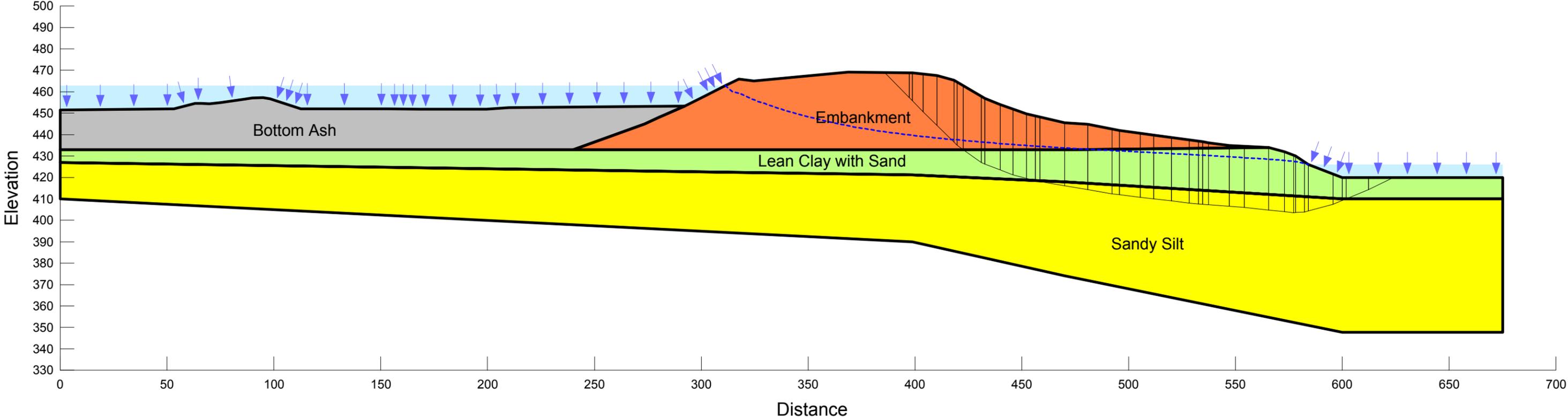
**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate**

Factor of Safety = 2.18

L03_50% PMF Pool, Downstream Slope Failure
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section C-C'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Drained Strength Parameters	
		Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay with Sand (Drained)	119	27.2	160
Sandy Silt (Drained)	130	30	0
Bottom Ash (Drained)	115	28	0



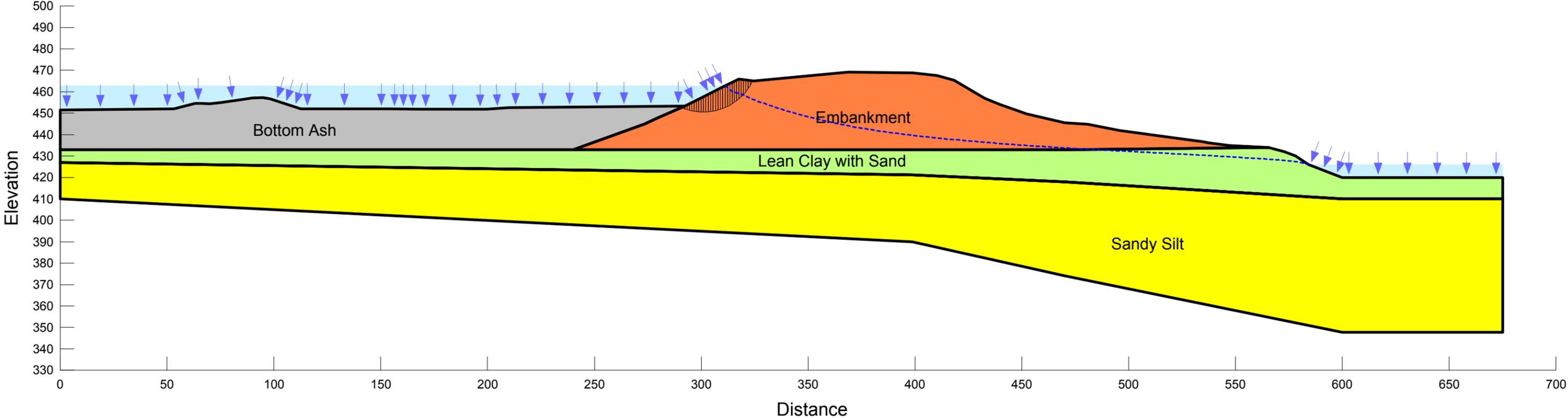
**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate**

Factor of Safety = 3.88

L04_50% PMF Pool, Upstream Slope Failure
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Incipient Motion in the Upstream Direction
Section C-C'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Drained Strength Parameters	
		Phi (deg.)	Cohesion (psf)
Embankment (Drained)	130	33.2	165
Lean Clay with Sand (Drained)	119	27.2	160
Sandy Silt (Drained)	130	30	0
Bottom Ash (Drained)	115	28	0



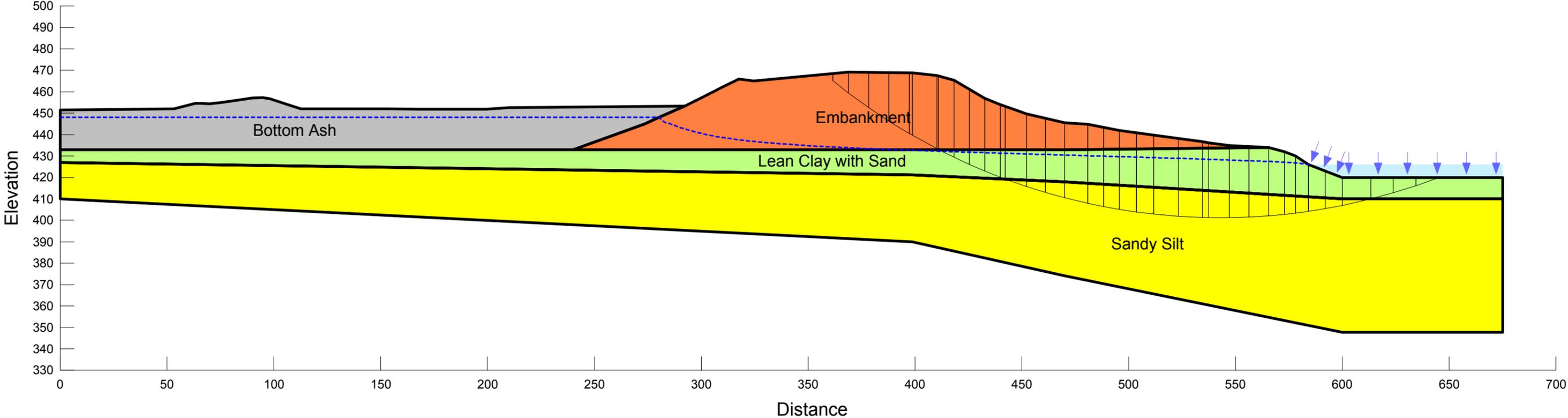
**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate**

Factor of Safety = 1.53

L05_Seismic_Normal Pool, Downstream Slope Failure
Normal Pool Elevation: 448 Feet
Undrained Static Strengths
Incipient Motion in the Downstream Direction
Horizontal Acc: 0.085g
Section C-C'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Drained Strength Parameters		Undrained Strength Parameters	
		Phi (deg.)	Cohesion (psf)	Phi (deg.)	Cohesion (psf)
Embankment (Seismic Undrained)	130	33.2	165	13	600
Lean Clay with Sand (Seismic Undrained)	119	27.2	160	5	1200
Sandy Silt (Seismic Undrained)	130	30	0	30	0
Bottom Ash (Seismic Undrained)	115	28	0	28	0



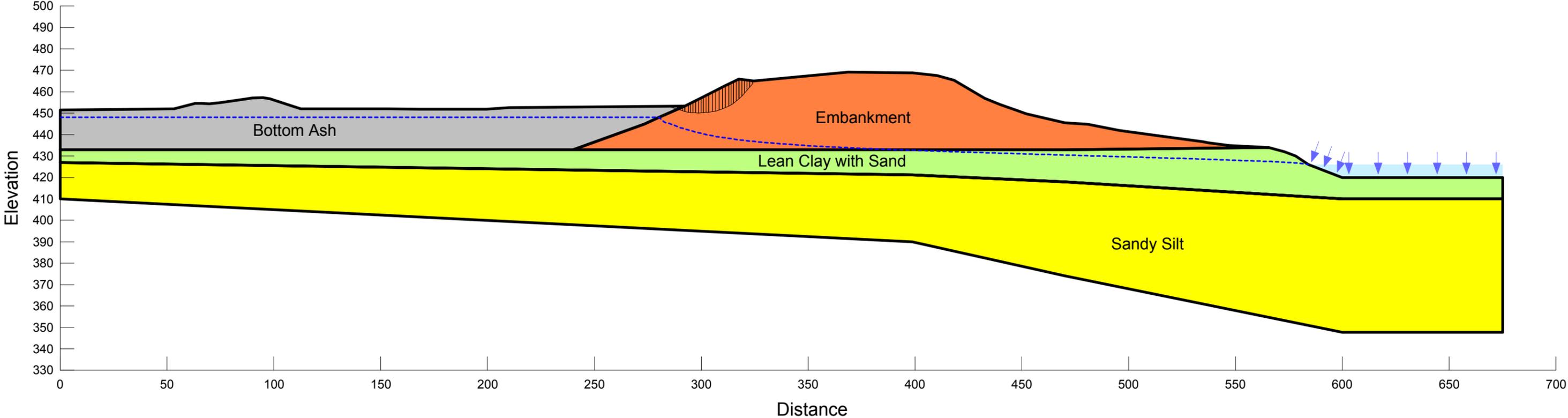
**American Electric Power (AEP)
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Madison, Indiana
CCR Mandate**

Factor of Safety = 2.25

L06_Seismic_Normal Pool, Upstream Slope Failure
Normal Pool Elevation: 448 Feet
Undrained Static Strengths
Incipient Motion in the Upstream Direction
Horizontal Acc: 0.085g
Section C-C'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Drained Strength Parameters		Undrained Strength Parameters	
		Phi (deg.)	Cohesion (psf)	Phi (deg.)	Cohesion (psf)
Embankment (Seismic Undrained)	130	33.2	165	13	600
Lean Clay with Sand (Seismic Undrained)	119	27.2	160	5	1200
Sandy Silt (Seismic Undrained)	130	30	0	30	0
Bottom Ash (Seismic Undrained)	115	28	0	28	0



LANDFILL RUNOFF COLLECTION POND:
2015 CCR MANDATE

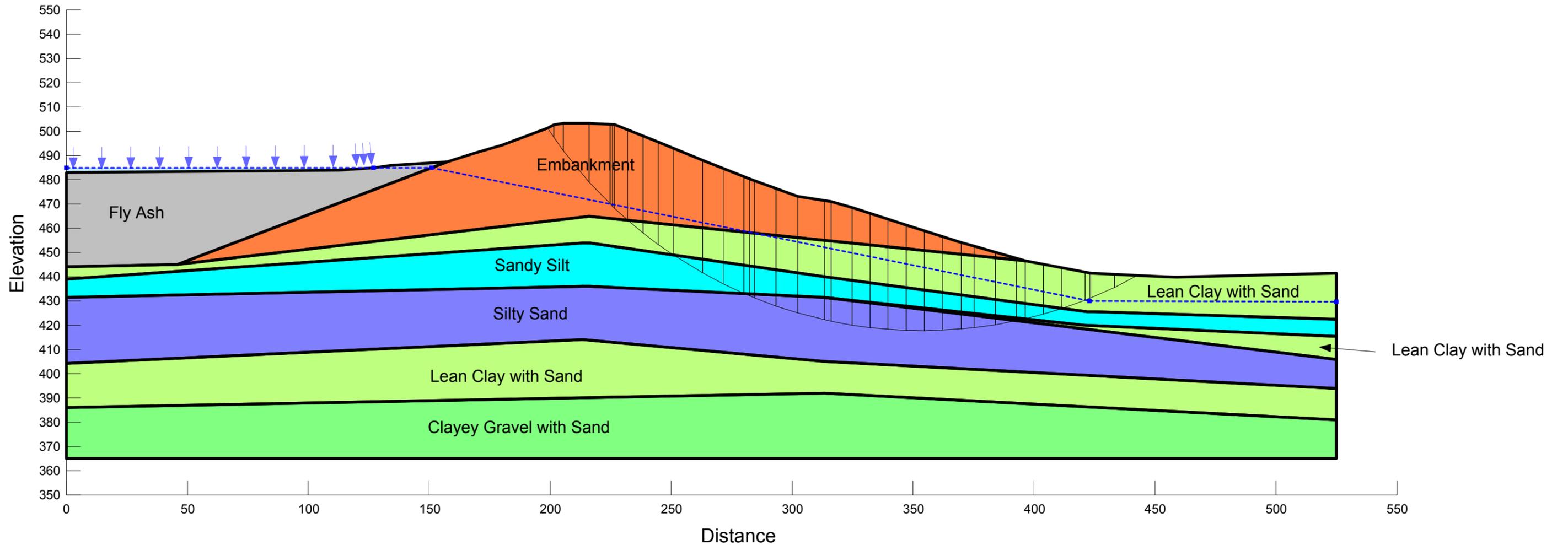
**American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate**

Factor of Safety = 1.85

L01_Normal Pool, Downstream Slope Failure
Normal Pool Elevation: 485 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section D-D'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Drained Strength Parameters			
Material	Unit Weight (pcf)	Phi (deg.)	Cohesion (psf)
Embankment (Drained)	129	27.5	198
Lean Clay with Sand (Drained)	127	28	206
Sandy Silt (Drained)	125	30	0
Silty Sand (Drained)	94	30	0
Clayey Gravel with Sand (Drained)	130	35	0
Fly Ash (Drained)	115	25	0



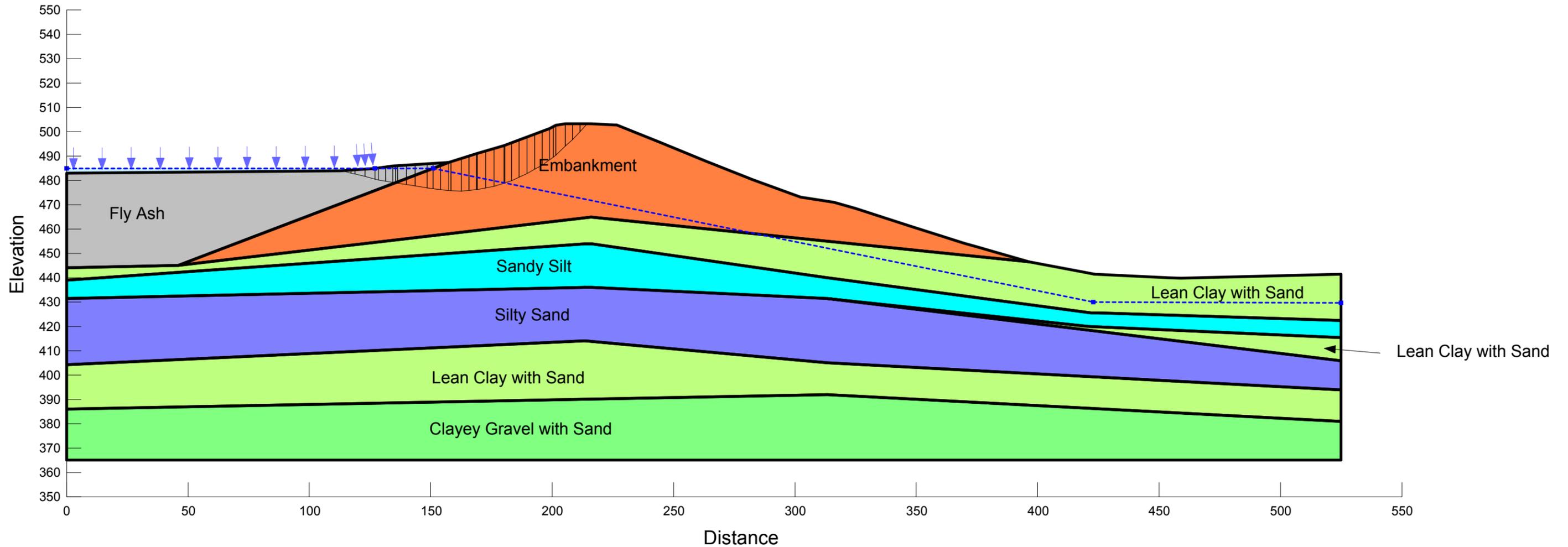
**American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate**

Factor of Safety = 2.73

L02_Normal Pool, Upstream Slope Failure
Normal Pool Elevation: 485 Feet
Drained Static Strengths
Incipient Motion in the Upstream Direction
Section D-D'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Drained Strength Parameters			
Material	Unit Weight (pcf)	Phi (deg.)	Cohesion (psf)
Embankment (Drained)	129	27.5	198
Lean Clay with Sand (Drained)	127	28	206
Sandy Silt (Drained)	125	30	0
Silty Sand (Drained)	94	30	0
Clayey Gravel with Sand (Drained)	130	35	0
Fly Ash (Drained)	115	25	0



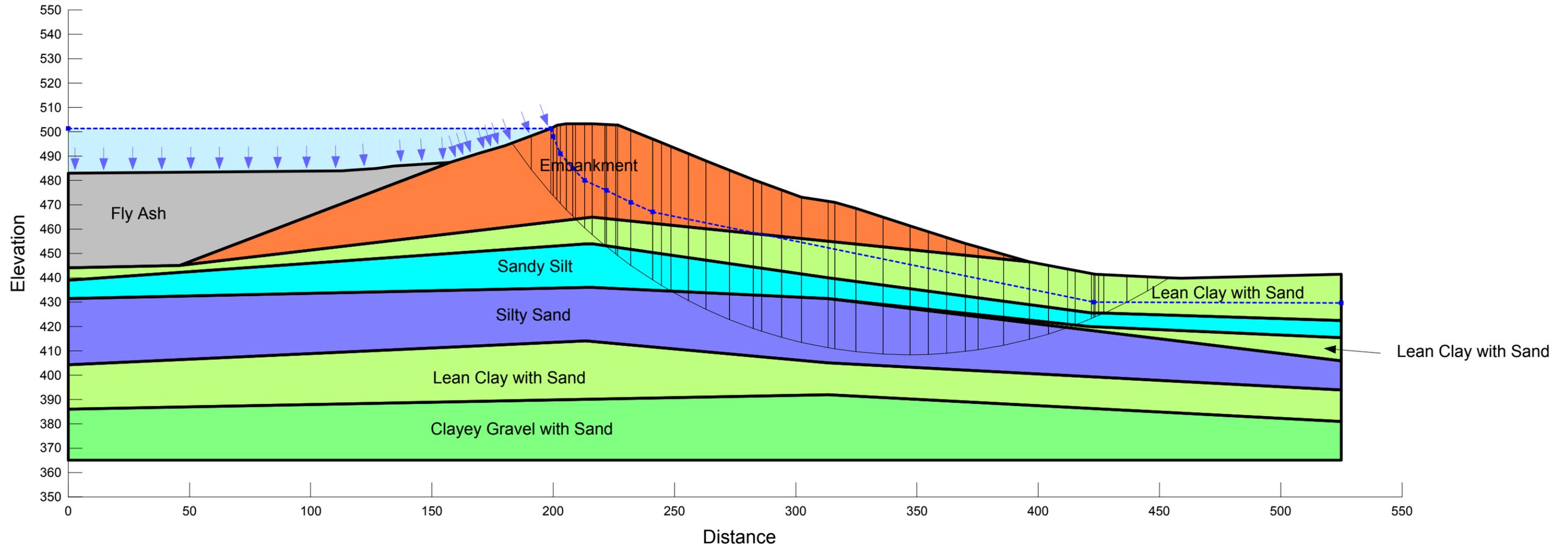
**American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate**

Factor of Safety = 1.81

L03_PMF Pool, Downstream Slope Failure
PMF Pool Elevation: 501.4 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section D-D'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Drained Strength Parameters			
Material	Unit Weight (pcf)	Phi (deg.)	Cohesion (psf)
Embankment (Drained)	129	27.5	198
Lean Clay with Sand (Drained)	127	28	206
Sandy Silt (Drained)	125	30	0
Silty Sand (Drained)	94	30	0
Clayey Gravel with Sand (Drained)	130	35	0
Fly Ash (Drained)	115	25	0



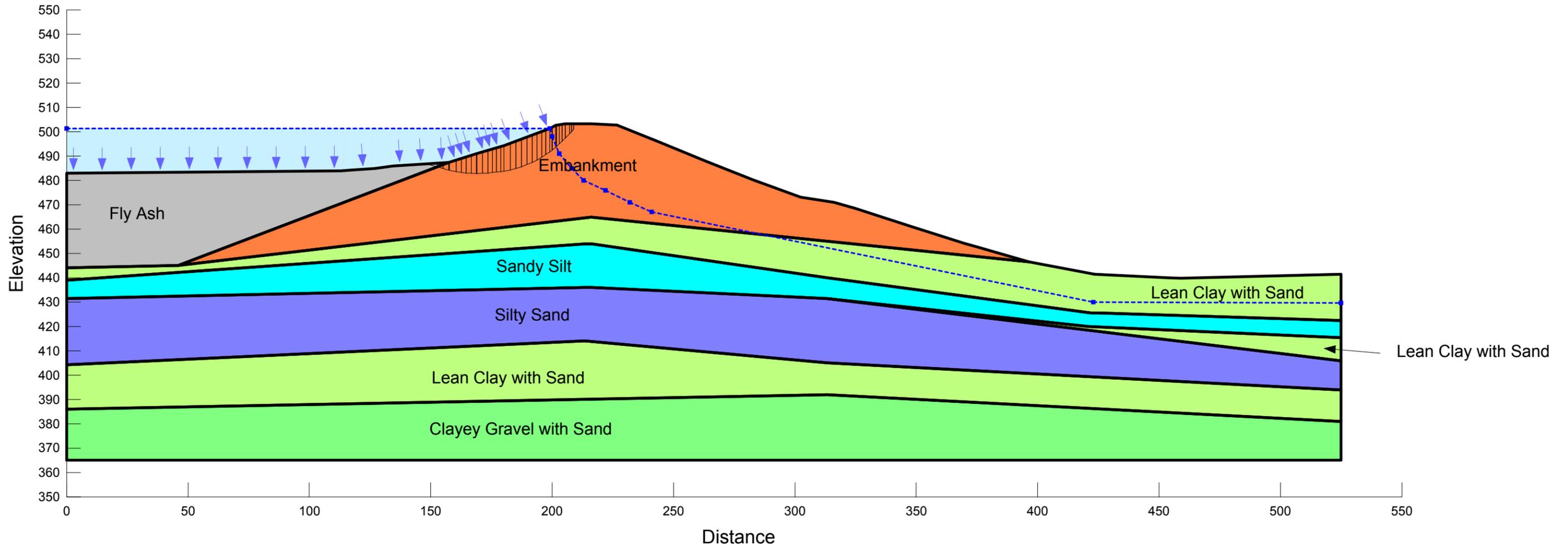
**American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate**

Factor of Safety = 3.47

L04_PMF Pool, Upstream Slope Failure
PMF Pool Elevation: 501.4 Feet
Drained Static Strengths
Incipient Motion in the Upstream Direction
Section D-D'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Drained Strength Parameters			
Material	Unit Weight (pcf)	Phi (deg.)	Cohesion (psf)
Embankment (Drained)	129	27.5	198
Lean Clay with Sand (Drained)	127	28	206
Sandy Silt (Drained)	125	30	0
Silty Sand (Drained)	94	30	0
Clayey Gravel with Sand (Drained)	130	35	0
Fly Ash (Drained)	115	25	0



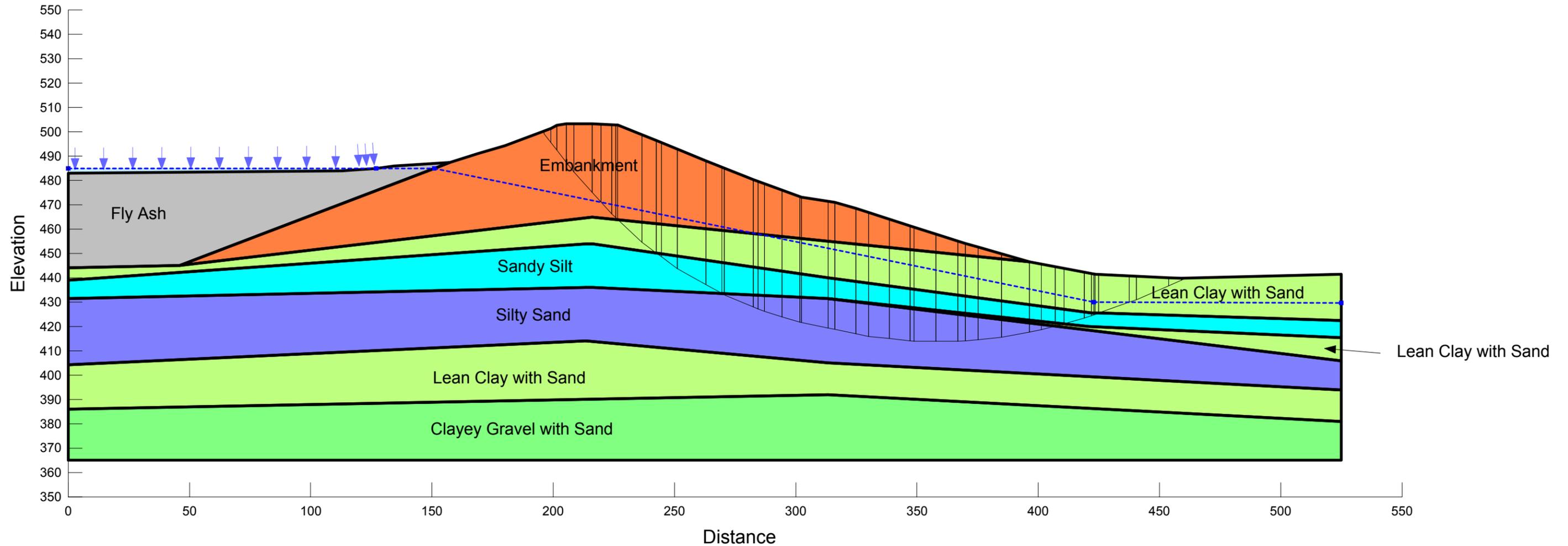
**American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate**

L05_Seismic_Normal Pool, Downstream Slope Failure
Normal Pool Elevation: 485 Feet
Undrained Static Strengths
Incipient Motion in the Downstream Direction
Horizontal Acc: 0.085g
Section D-D'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Factor of Safety = 1.42

Material	Unit Weight (pcf)	Drained Strength Parameters		Undrained Strength Parameters	
		Phi (deg.)	Cohesion (psf)	Phi (deg.)	Cohesion (psf)
Embankment (Seismic Undrained)	129	27.5	198	21	1400
Lean Clay with Sand (Seismic Undrained)	127	28	206	17	1200
Sandy Silt (Seismic Undrained)	125	30	0	30	0
Silty Sand (Seismic Undrained)	94	30	0	30	0
Clayey Gravel with Sand (Seismic Undrained)	130	35	0	35	0
Fly Ash (Seismic Undrained)	115	25	0	25	0



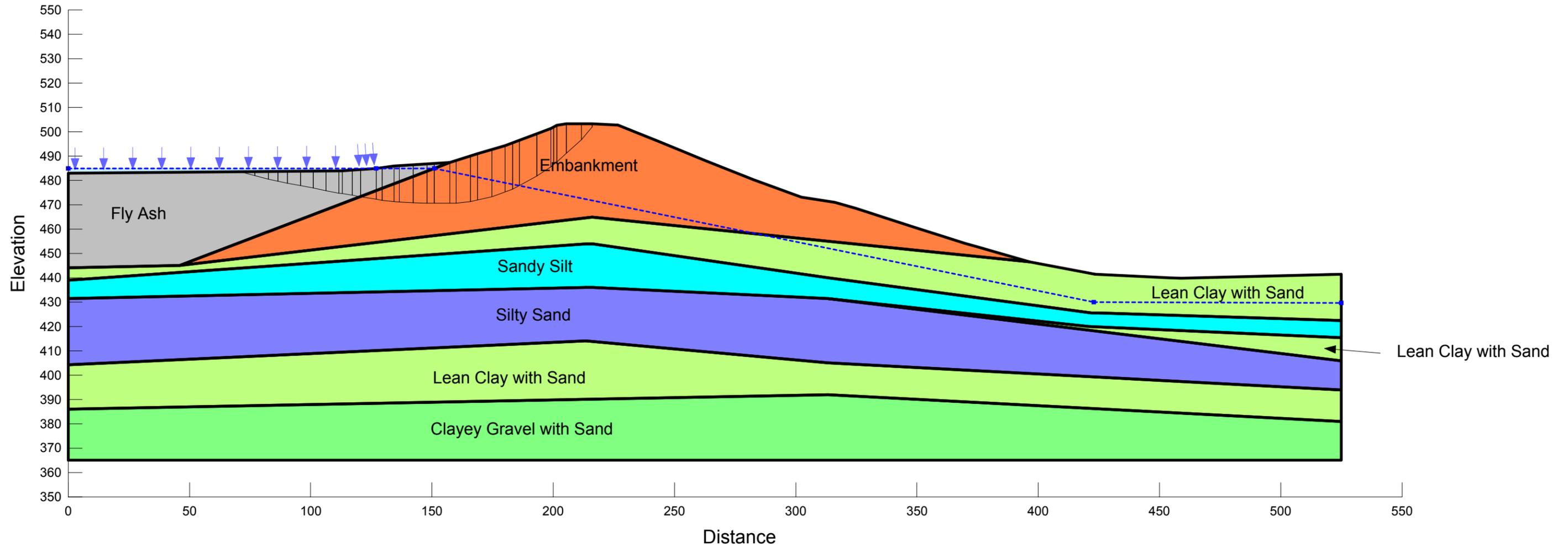
**American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate**

L06_Seismic_Normal Pool, Upstream Slope Failure
Normal Pool Elevation: 485 Feet
Undrained Static Strengths
Incipient Motion in the Upstream Direction
Horizontal Acc: 0.085g
Section D-D'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Factor of Safety = 1.94

Material	Unit Weight (pcf)	Drained Strength Parameters		Undrained Strength Parameters	
		Phi (deg.)	Cohesion (psf)	Phi (deg.)	Cohesion (psf)
Embankment (Seismic Undrained)	129	27.5	198	21	1400
Lean Clay with Sand (Seismic Undrained)	127	28	206	17	1200
Sandy Silt (Seismic Undrained)	125	30	0	30	0
Silty Sand (Seismic Undrained)	94	30	0	30	0
Clayey Gravel with Sand (Seismic Undrained)	130	35	0	35	0
Fly Ash (Seismic Undrained)	115	25	0	25	0



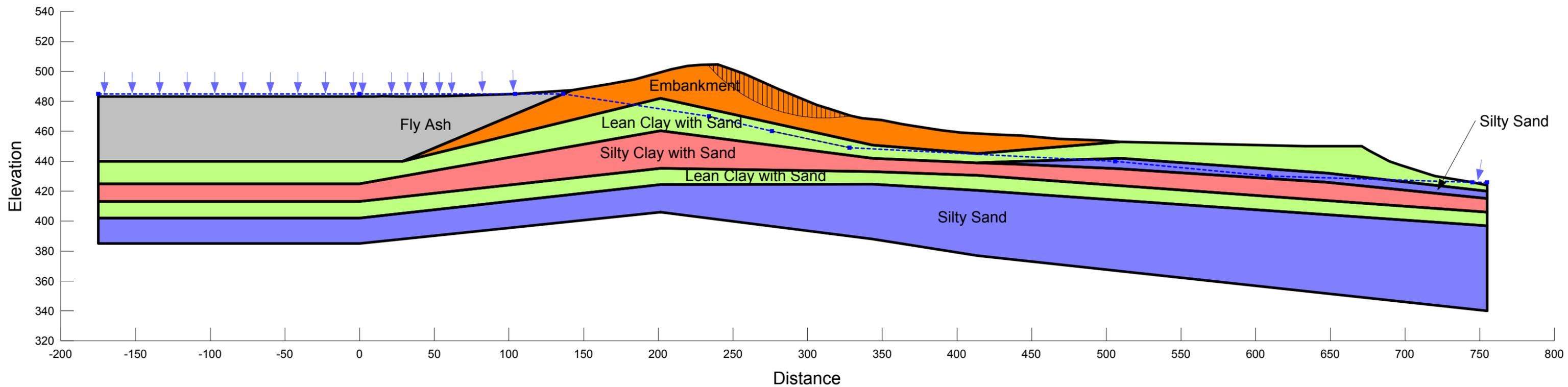
**American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate**

Factor of Safety = 1.99

L01_Normal Pool, Downstream Crest Loss
Normal Pool Elevation: 485 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section E-E'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Phi (deg.)	Cohesion (psf)
Embankment (Drained)	129	27.5	198
Lean Clay with Sand (Drained)	127	28	206
Silty Sand (Drained)	94	30	0
Fly Ash (Drained)	115	25	0
Silty Clay with Sand (Drained)	118	34	152



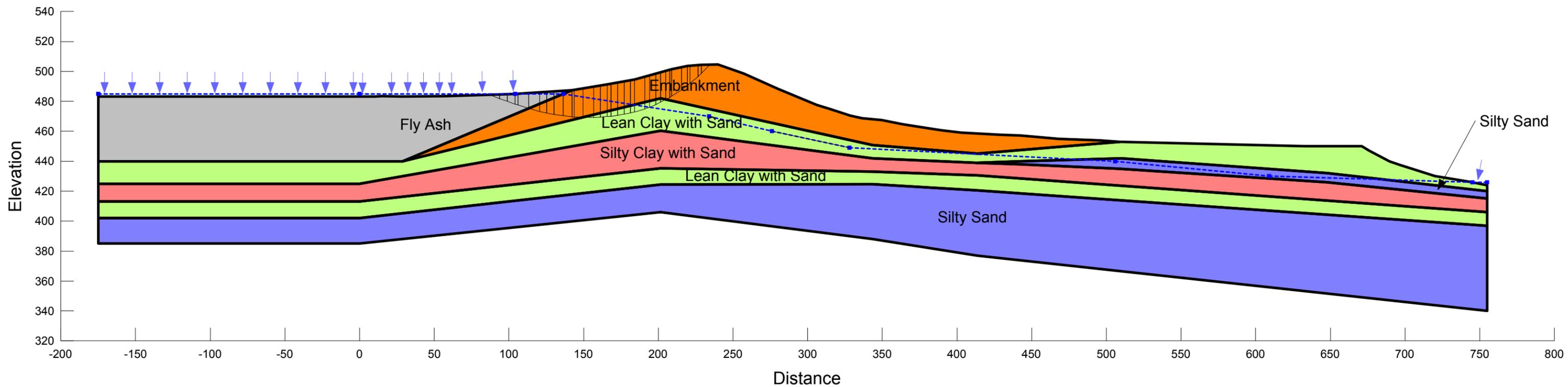
**American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate**

Factor of Safety = 3.51

L02_Normal Pool, Upstream Crest Loss
Normal Pool Elevation: 485 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section E-E'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Drained Strength Parameters			
Material	Unit Weight (pcf)	Phi (deg.)	Cohesion (psf)
Embankment (Drained)	129	27.5	198
Lean Clay with Sand (Drained)	127	28	206
Silty Sand (Drained)	94	30	0
Fly Ash (Drained)	115	25	0
Silty Clay with Sand (Drained)	118	34	152



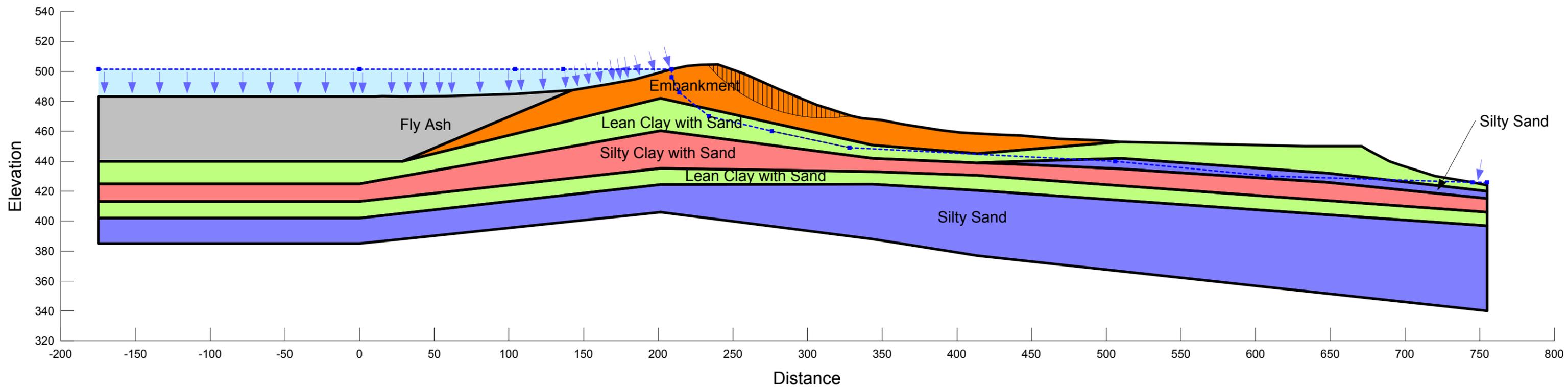
**American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate**

Factor of Safety = 1.99

L03_PMF Pool, Downstream Crest Loss
PMF Pool Elevation: 501.4 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section E-E'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Phi (deg.)	Cohesion (psf)
Embankment (Drained)	129	27.5	198
Lean Clay with Sand (Drained)	127	28	206
Silty Sand (Drained)	94	30	0
Fly Ash (Drained)	115	25	0
Silty Clay with Sand (Drained)	118	34	152



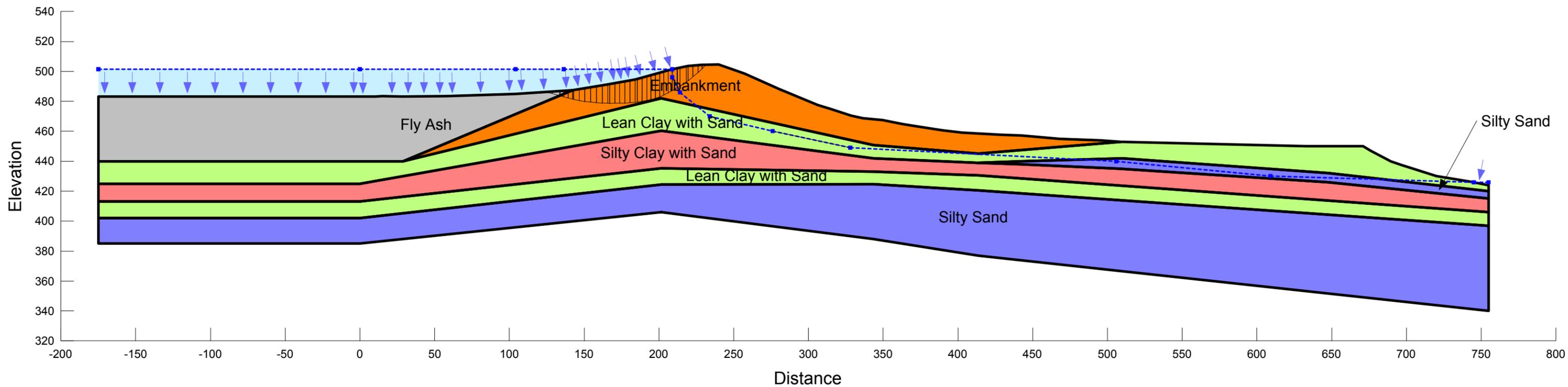
**American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate**

Factor of Safety = 4.51

L04_PMF Pool, Upstream Crest Loss
PMF Pool Elevation: 501.4 Feet
Drained Static Strengths
Incipient Motion in the Downstream Direction
Section E-E'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Material	Unit Weight (pcf)	Phi (deg.)	Cohesion (psf)
Embankment (Drained)	129	27.5	198
Lean Clay with Sand (Drained)	127	28	206
Silty Sand (Drained)	94	30	0
Fly Ash (Drained)	115	25	0
Silty Clay with Sand (Drained)	118	34	152



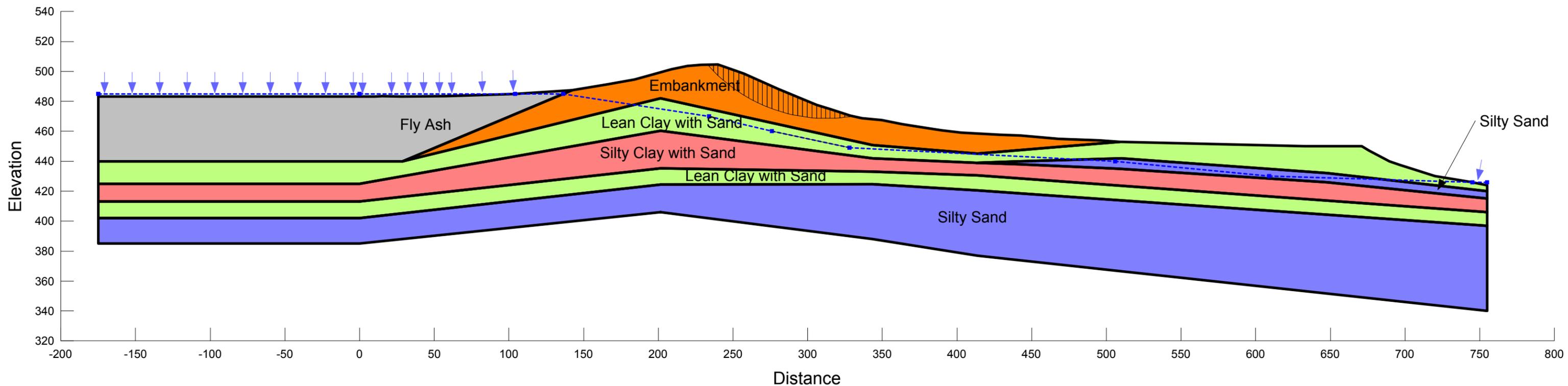
**American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate**

L05_Seismic_Normal Pool, Downstream Crest Loss
Normal Pool Elevation: 485 Feet
Undrained Static Strengths
Incipient Motion in the Downstream Direction
Horizontal Acc: 0.085g
Section E-E'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Factor of Safety = 1.64

Material	Unit Weight (pcf)	Drained Strength Parameters		Undrained Strength Parameters	
		Phi (deg.)	Cohesion (psf)	Phi (deg.)	Cohesion (psf)
Embankment (Seismic Undrained)	129	27.5	198	21	1400
Lean Clay with Sand (Seismic Undrained)	127	28	206	17	1200
Silty Sand (Seismic Undrained)	94	30	0	30	0
Fly Ash (Seismic Undrained)	115	25	0	25	0
Silty Clay with Sand (Seismic Undrained)	118	34	152	20	1000



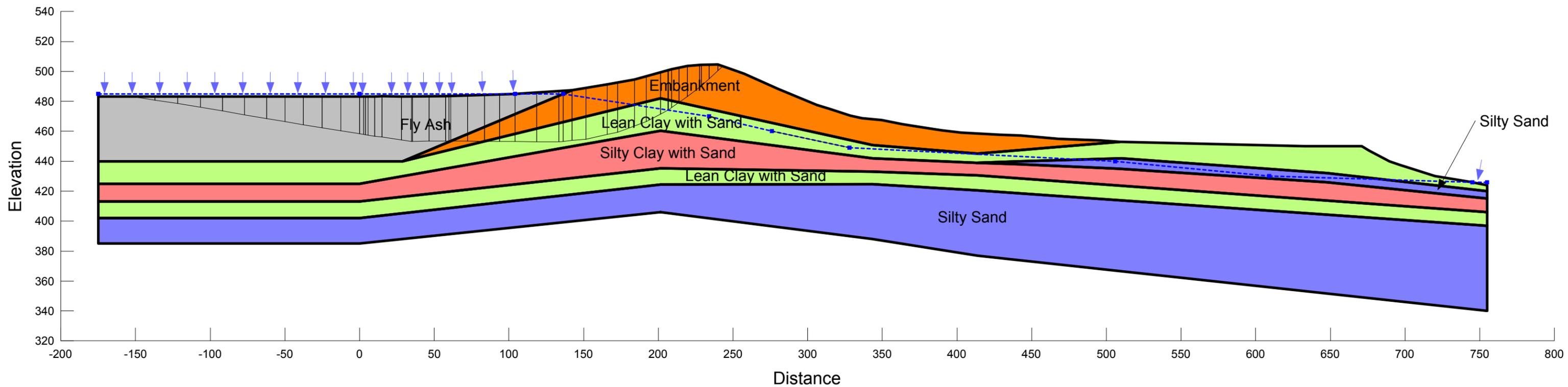
**American Electric Power (AEP)
Clifty Creek Landfill Runoff Collection Pond Dam
Madison, Indiana
CCR Mandate**

L06_Seismic_Normal Pool, Upstream Crest Loss
Normal Pool Elevation: 485 Feet
Undrained Static Strengths
Incipient Motion in the Upstream Direction
Horizontal Acc: 0.085g
Section E-E'

Note: The results of the analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. The drawing depicts approximate subsurface conditions based on historical drawings or specific borings at the time of drilling. No warranties can be made regarding the continuity of subsurface conditions.

Factor of Safety = 2.28

Material	Unit Weight (pcf)	Drained Strength Parameters		Undrained Strength Parameters	
		Phi (deg.)	Cohesion (psf)	Phi (deg.)	Cohesion (psf)
Embankment (Seismic Undrained)	129	27.5	198	21	1400
Lean Clay with Sand (Seismic Undrained)	127	28	206	17	1200
Silty Sand (Seismic Undrained)	94	30	0	30	0
Fly Ash (Seismic Undrained)	115	25	0	25	0
Silty Clay with Sand (Seismic Undrained)	118	34	152	20	1000



SEEP MODELS, 2015

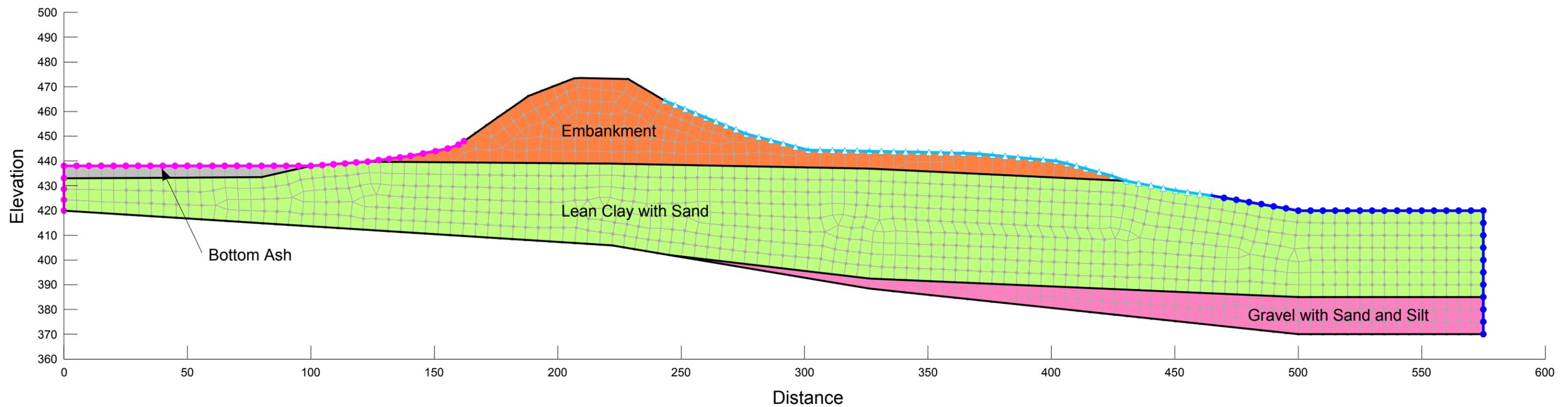
**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate**

**Seepage Analysis
Boundary Condition and Mesh**

SEEP Steady State Normal Pool
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Section A-A'

Material	Kh-sat (ft/sec)	Kratio Kv/Kh	Sat. Water Content ft ³ /ft ³	Res. Water Content ft ³ /ft ³
Embankment (Drained)	4.72e-008	0.1	0.38	0.109
Lean Clay with Sand (Drained)	2.83e-007	0.1	0.41	0.09
Gravel With Silt and Sand (Drained)	0.00164	0.2	0.23	0.01
Bottom Ash (Drained)	0.0115	1	0.3548	0.027

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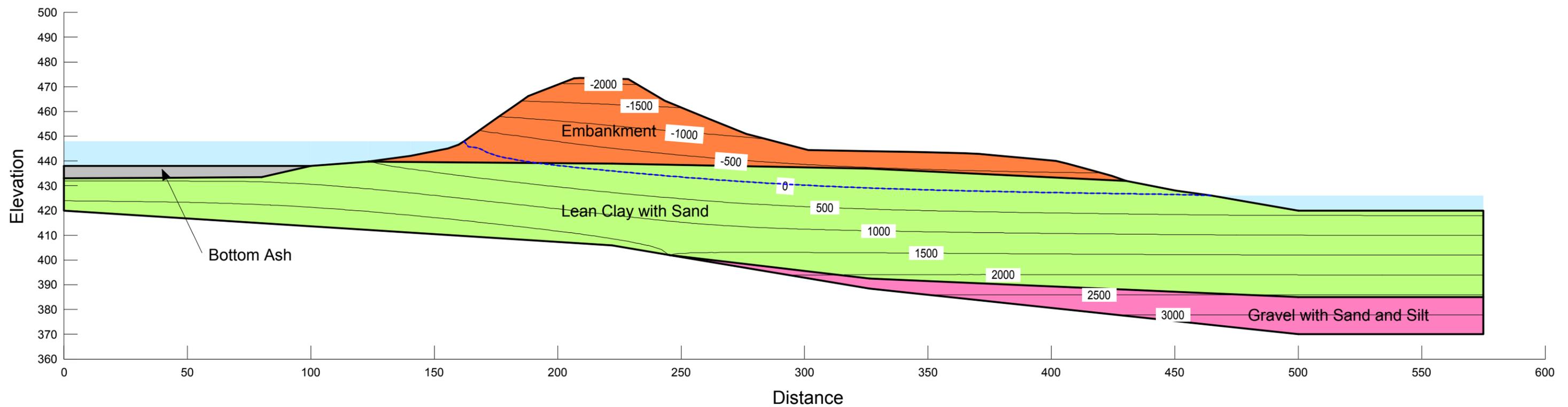
**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate**

**Seepage Analysis
Pore Water Pressure Contour (psf)**

SEEP Steady State Normal Pool
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Section A-A'

Material	Kh-sat (ft/sec)	Kratio Kv/Kh	Sat. Water Content ft ³ /ft ³	Res. Water Content ft ³ /ft ³
Embankment (Drained)	4.72e-008	0.1	0.38	0.109
Lean Clay with Sand (Drained)	2.83e-007	0.1	0.41	0.09
Gravel With Silt and Sand (Drained)	0.00164	0.2	0.23	0.01
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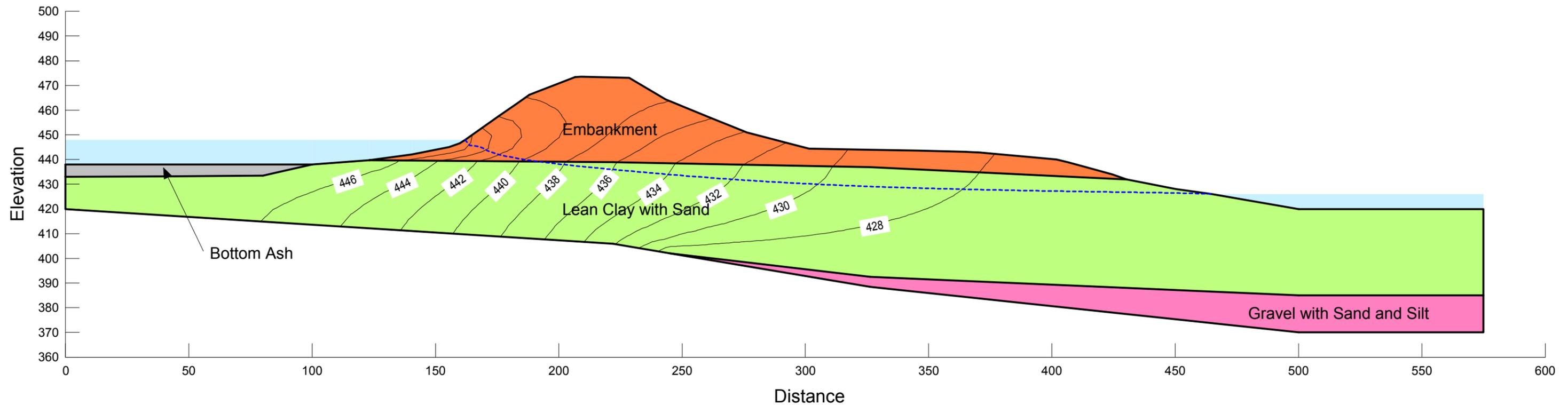
**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate**

**Seepage Analysis
Total Head Contour (feet)**

SEEP Steady State Normal Pool
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Section A-A'

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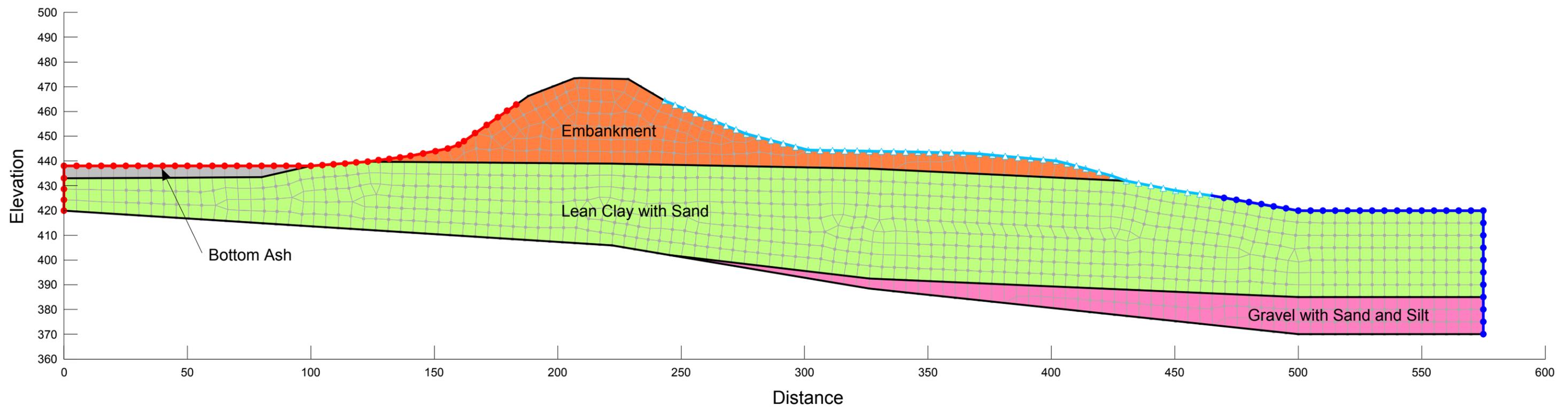
**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate**

**Seepage Analysis
Boundary Condition and Mesh**

SEEP Steady State 50% PMF Pool
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Section A-A'

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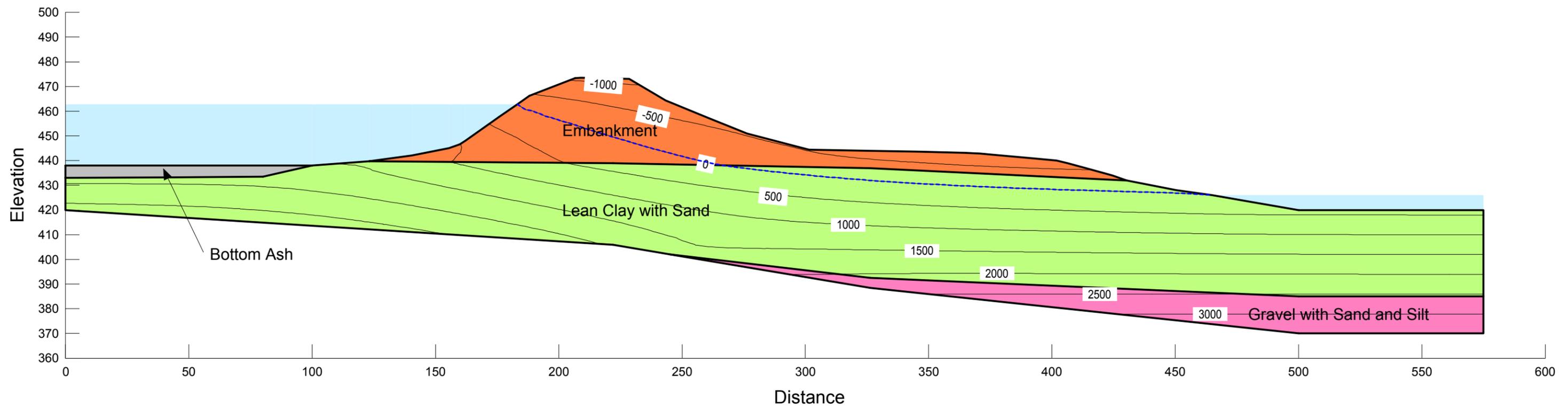
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CCR Mandate**

**Seepage Analysis
Pore Water Pressure Contour (psf)**

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Drained Static Strengths
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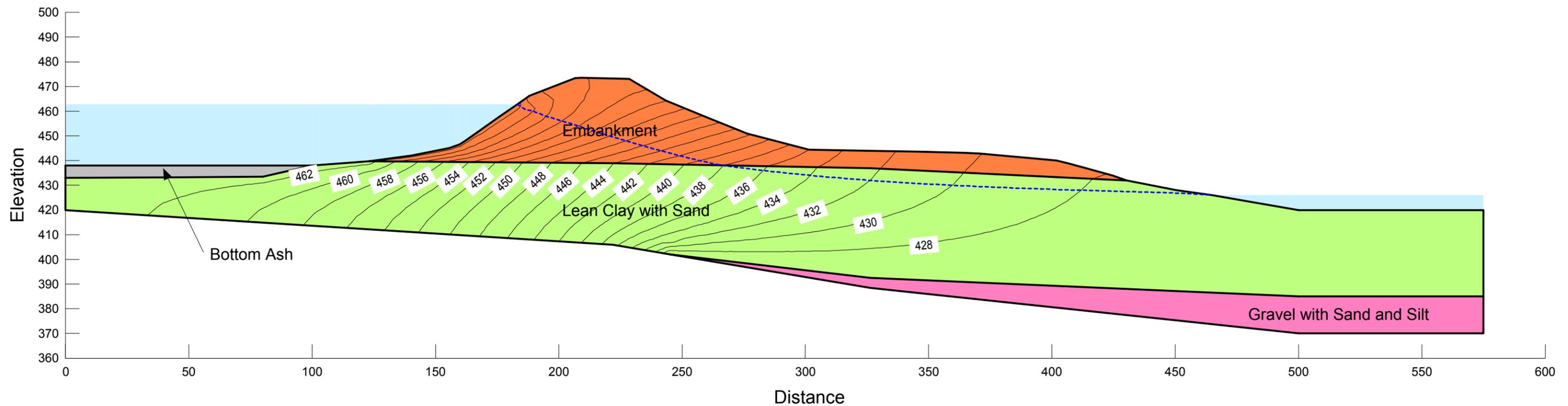
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CCR Mandate**

**Seepage Analysis
Total Head Contour (feet)**

SEEP Steady State 50% PMF Pool
50% PMF Pool Elevation: 462.8 Feet
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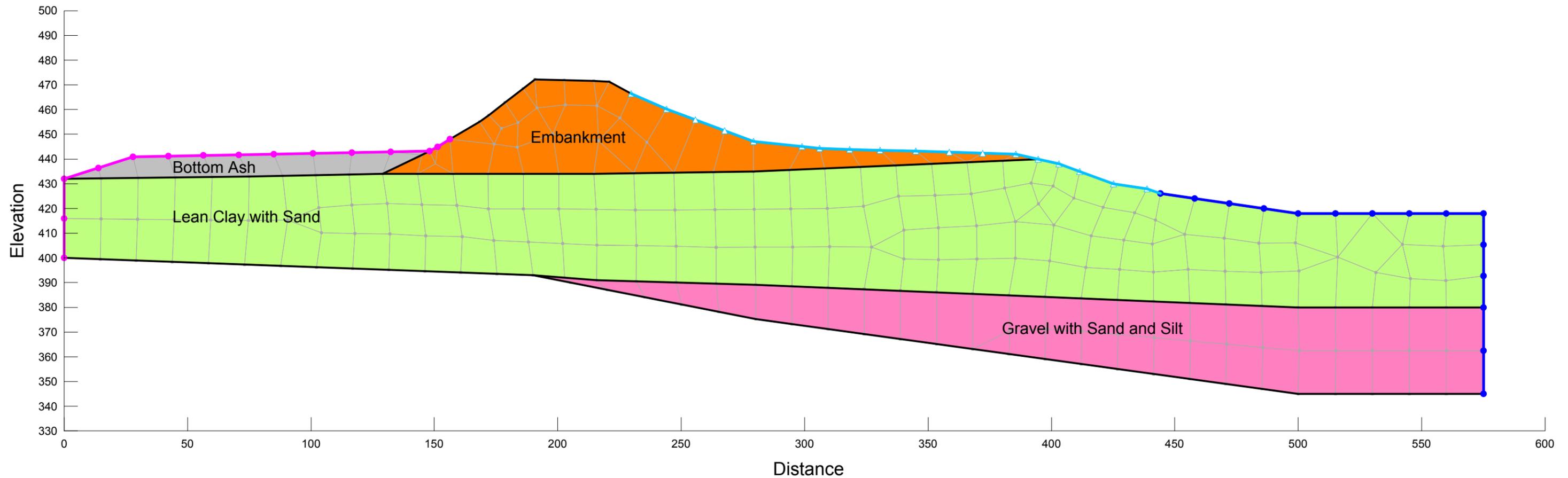
**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
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CCR Mandate**

**Seepage Analysis
Boundary Condition and Mesh**

SEEP Steady State Normal Pool
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Section B-B'

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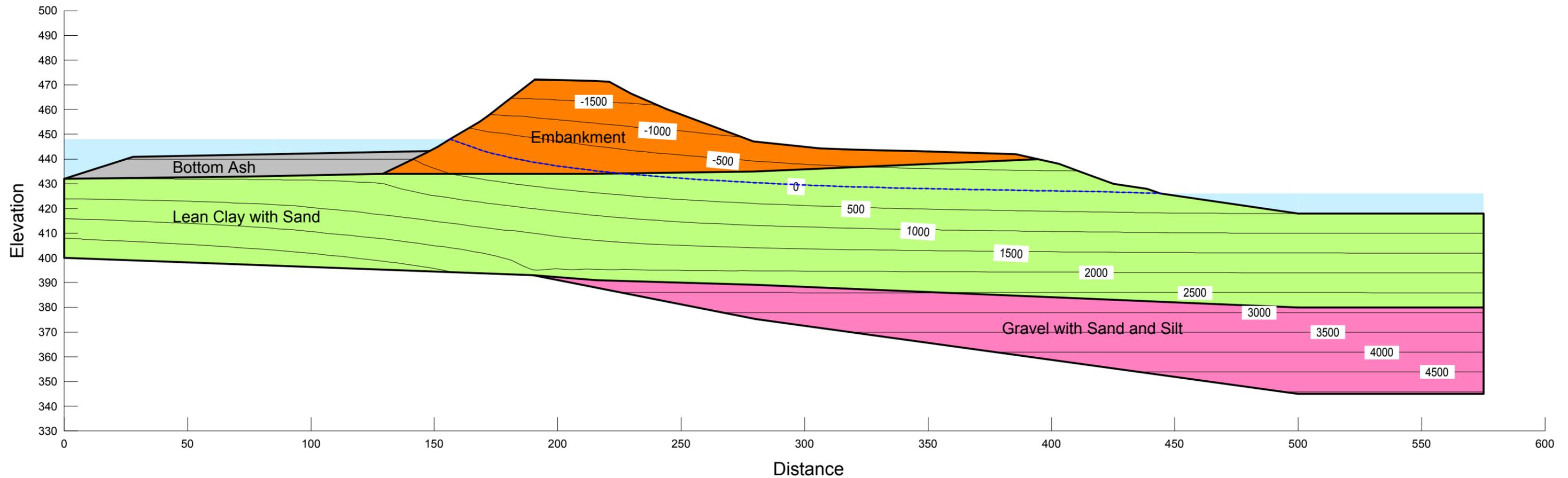
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**Seepage Analysis
Pore Water Pressure Contour (psf)**

SEEP Steady State Normal Pool
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Section B-B'

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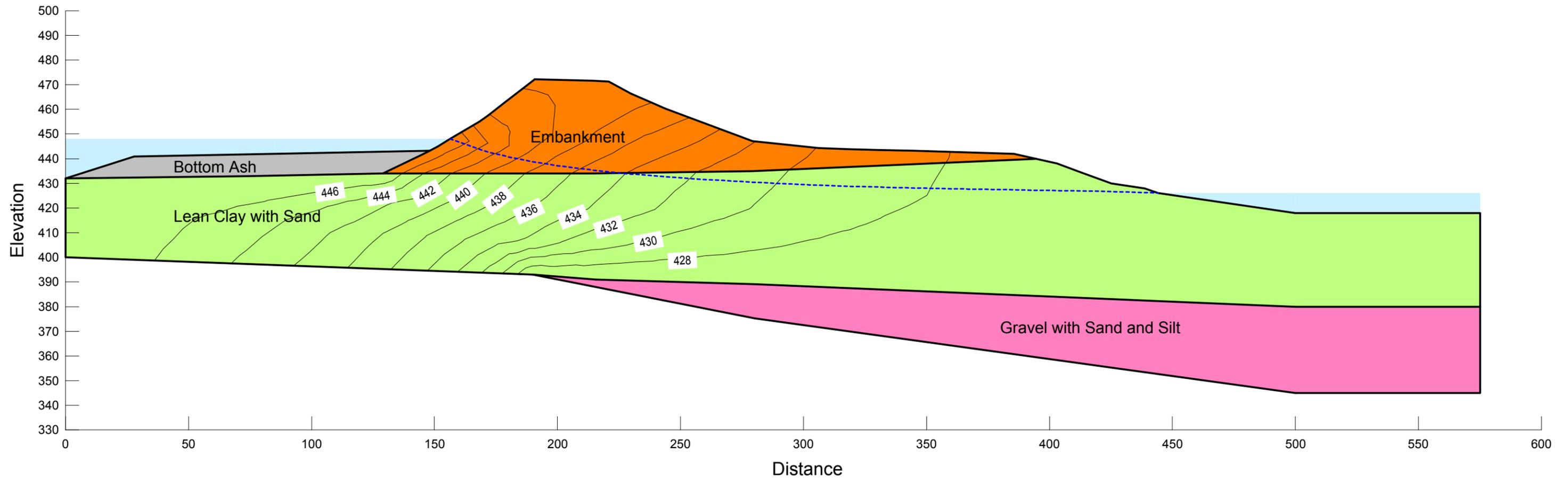
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Total Head Contour (feet)**

SEEP Steady State Normal Pool
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Drained Static Strengths
Section B-B'

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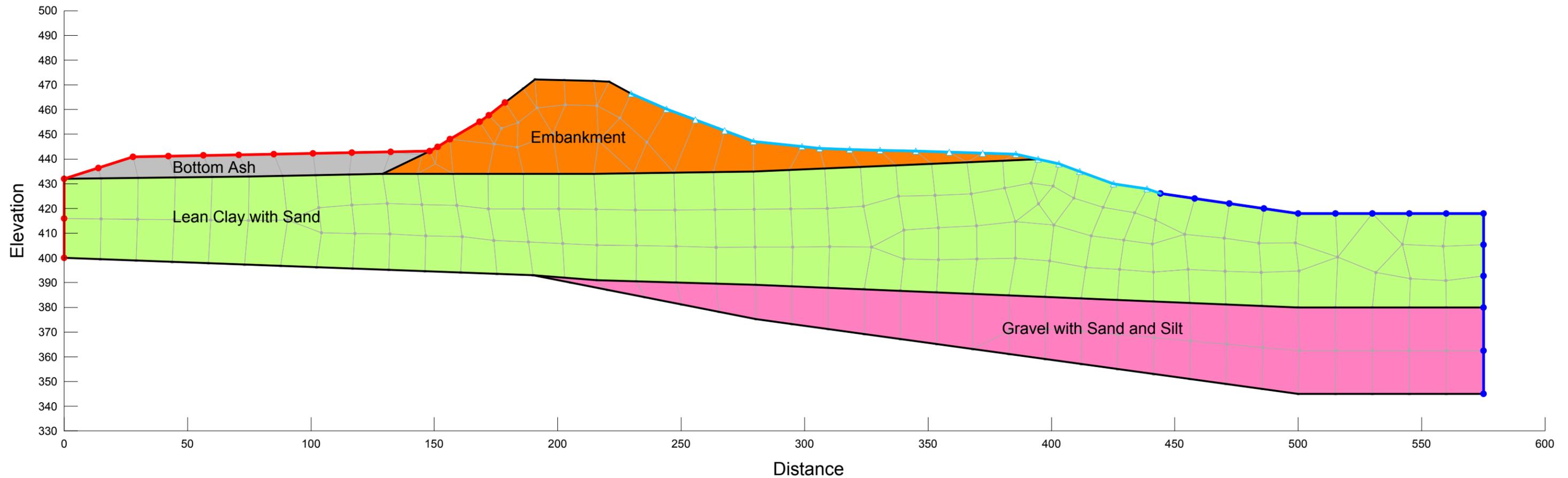
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CCR Mandate**

**Seepage Analysis
Boundary Condition and Mesh**

SEEP Steady State 50% PMF Pool
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Section B-B'

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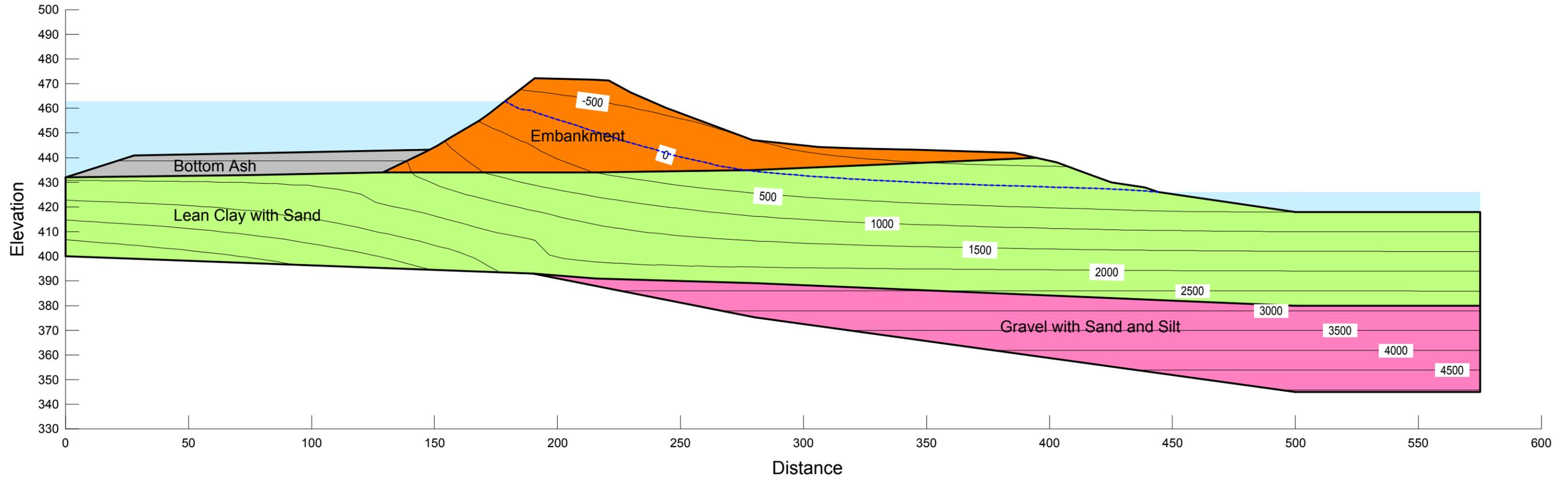
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Pore Water Pressure Contour (psf)**

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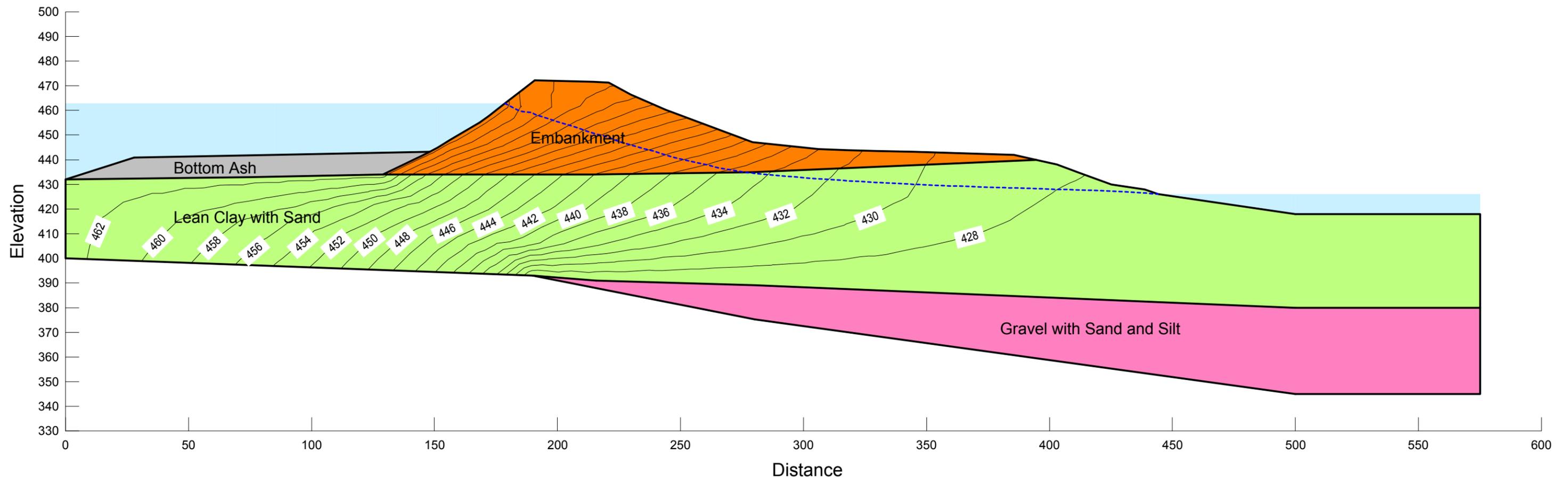
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Total Head Contour (feet)**

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Section B-B'

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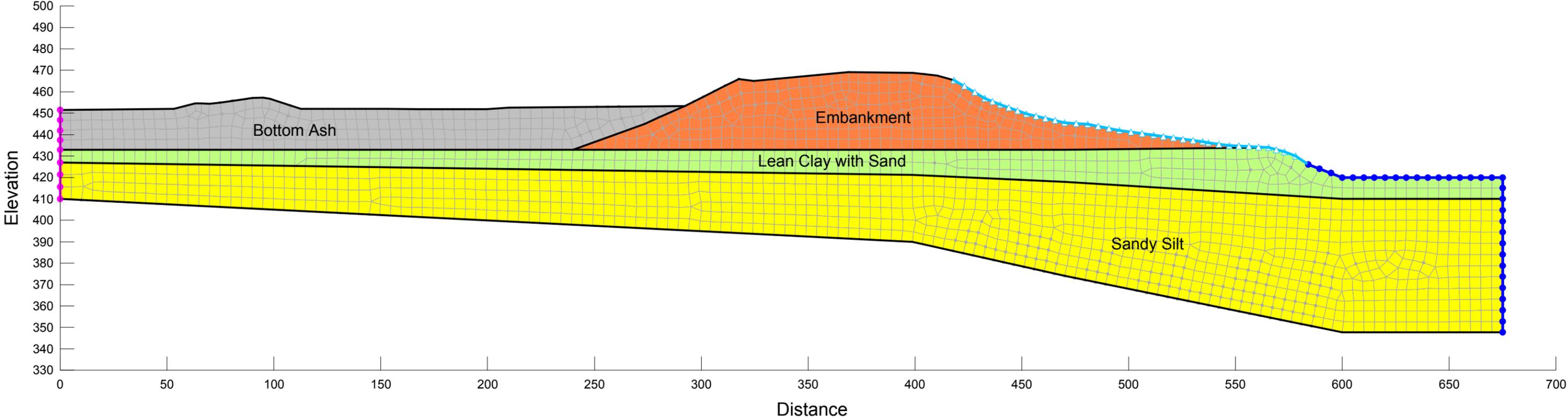
**American Electric Power (AEP)
Clifty Creek West Boiler Slag Pond Dam
Madison, Indiana
CCR Mandate**

**Seepage Analysis
Boundary Condition and Mesh**

SEEP Steady State Normal Pool
Normal Pool Elevation: 448 Feet
Drained Static Strengths
Section C-C'

Material	Kh-sat (ft/sec)	Kratio Kv/Kh	Sat. Water Content ft ³ /ft ³	Res. Water Content ft ³ /ft ³
Embankment (Drained)	4.72e-008	0.1	0.38	0.109
Lean Clay with Sand (Drained)	2.83e-007	0.1	0.41	0.09
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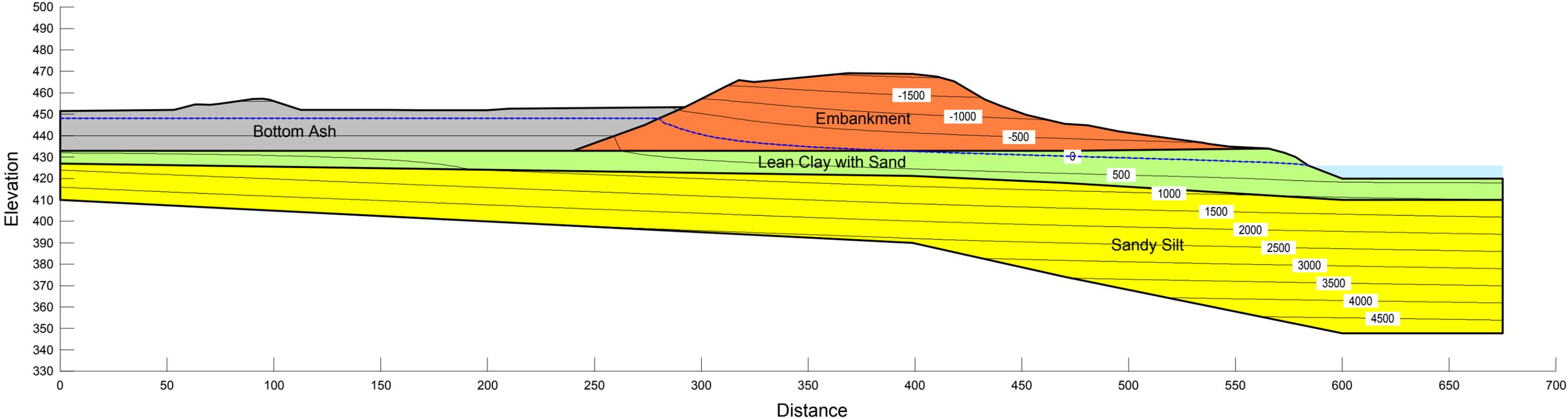
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Madison, Indiana
CCR Mandate**

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Pore Water Pressure Contour (psf)**

SEEP Steady State Normal Pool
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Drained Static Strengths
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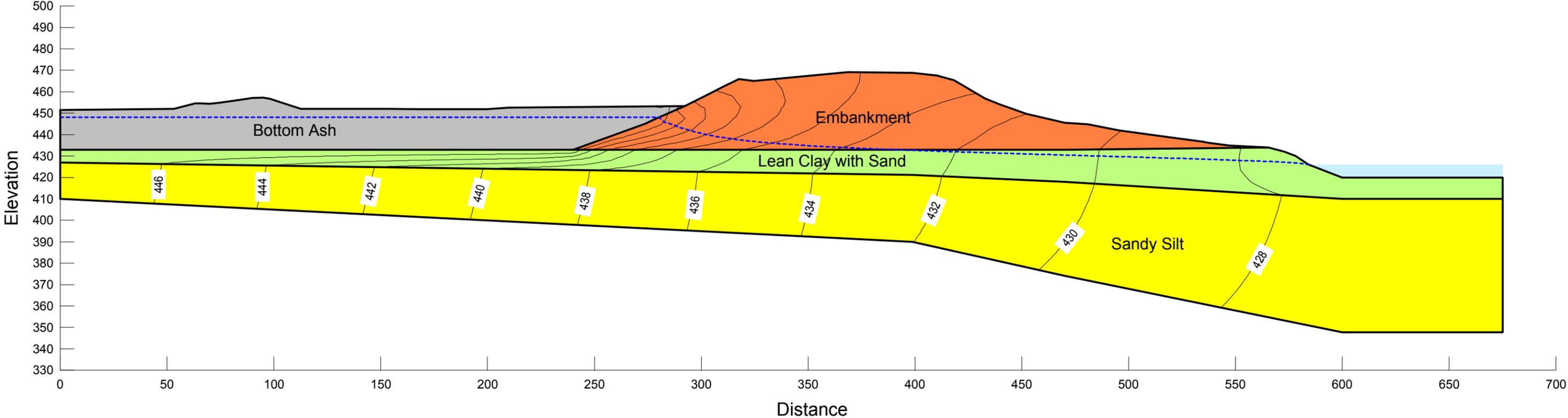
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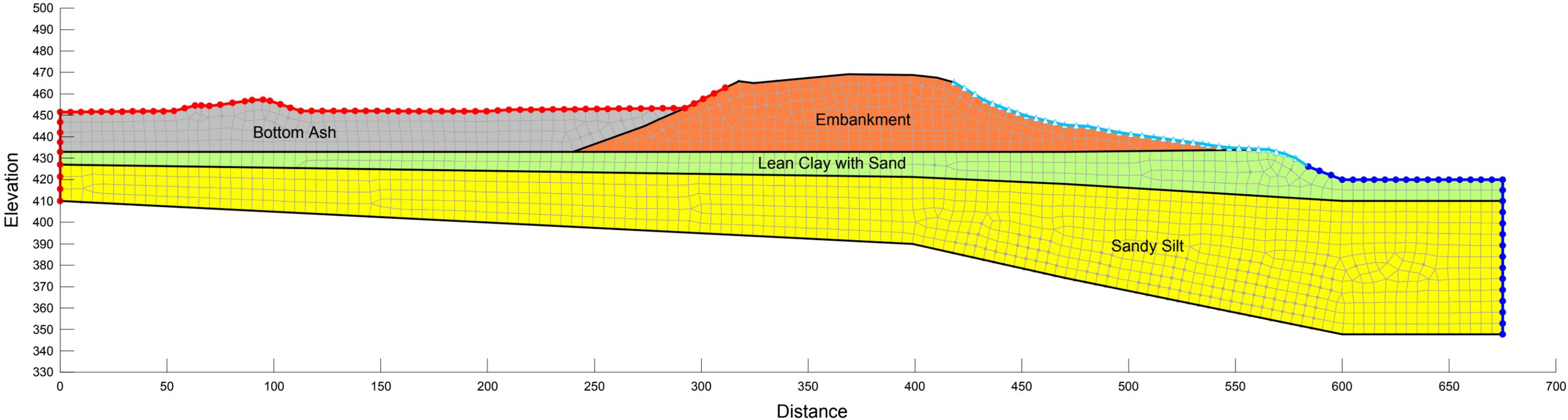
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**Seepage Analysis
Boundary Condition and Mesh**

SEEP Steady State 50% PMF Pool
50% PMF Pool Elevation: 462.8 Feet
Drained Static Strengths
Section C-C'

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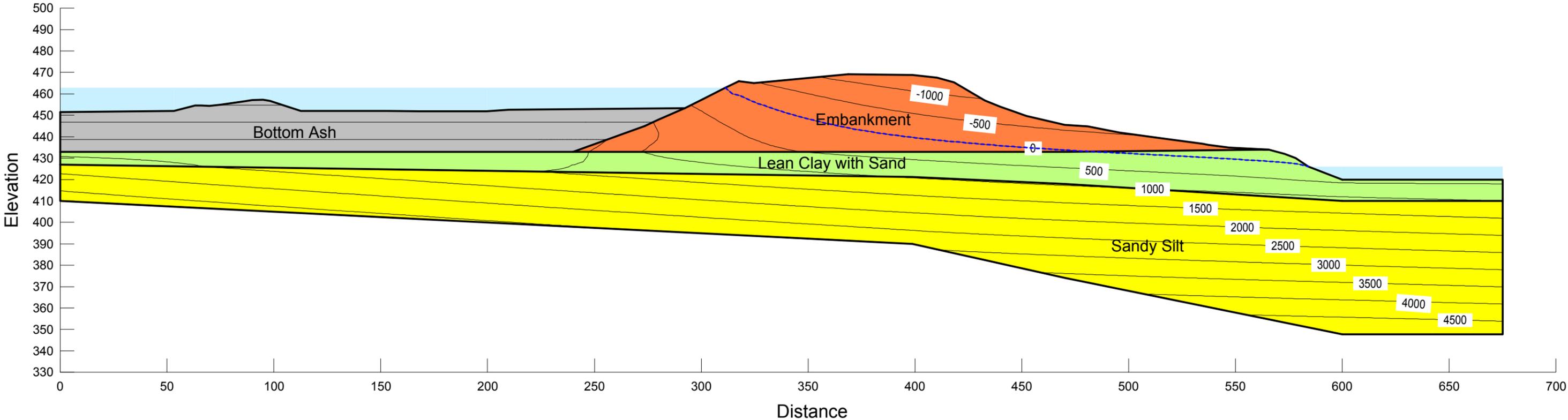
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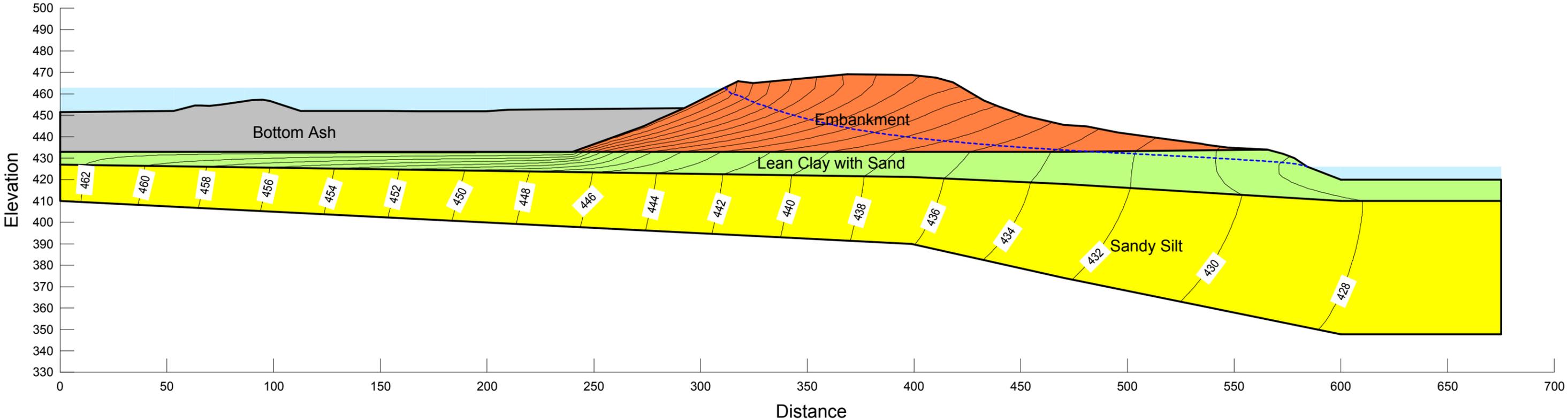
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APPENDIX J

PARAMETER DERIVATIONS

BOILER SLAG POND DAM: 2010 PARAMETER DERIVATIONS

WEST BOTTOM ASH DAM GEOTECHNICAL ANALYSIS

CALCULATION SHEET

I. Subsurface Exploration Program Development:

Three cross sections across the dam were analyzed with two borings on each section: On the crest and at the toe.

II. Laboratory Testing Program:

The program was developed based on visual classifications done in the field during subsurface exploration.

- USCS Soil Classification Tests
- CU Triaxial Compression Tests
- Permeability Tests.
- Moisture Density tests.

III. Geotechnical Analysis:

A soil tests summary was developed to select soil parameters to use in the geotechnical analysis. Engineering properties that were not directly tested were determined using typical soil parameter values from NAVFAC DM7-02 Foundations and Earth Structures (Table 1 on Page 39) and the Center For Geotechnical Practice and Research, Performance and Use of the Standard Penetration Test in Geotechnical Engineering Practice report (Figures 34 and 35 on pages 71 and 72 respectively). The two tables are attached at the end of the parameter derivation notes.

Permeability k values that were not tested in the laboratory were selected from typical values provided in the table below and those provided in NAVFAC DM7.02, table 1: Typical Properties of Compacted soils

Soil Type	k_v (cm/s)
Coarse Sand	$>10^{-1}$
Fine Sand	10^{-1} to 10^{-3}
Silty Sand	10^{-3} to 10^{-5}
Silt	10^{-5} to 10^{-7}
Clay	$<10^{-7}$

Soils from the West Bottom Ash Dam were classified into 5 main soil layers.

The following table shows how pertinent parameters were selected and which sections they were applied to.

Soil name	USCS class	Classification Samples	Shear Strength Parameters	Permeability Parameters	Section
Embankment fill	CL	B-1,(10-11.5)(12.5-14)	Triaxial Test No 1	Test ID 7A	A / B / C
Lean Clay with Sand	CL	B-2,(32.5-34)(35-36.5)	Triaxial Test No 2	Average of test ID 48A & 82A	A / B / C
Gravel With Silt and Sand	GW-GM	B-4,(57.5-59)(60-61.5)	Typical values *	Typical values *	A / B
Sand Silt/ Silt with Sand	ML	B-5,(55-56.5)(57.5-59)	Typical values *	Typical values *	C
Bottom Ash		Averaged results from WBAP trench testing.**	Typical values *	Averaged results from WBAP trench testing.	A / B / C

* Typical values as determined from referenced tables.

** Table attached at end of appendix

Soil name	Unit Weight	C	ϕ	K_v (cm/sec)	K_h/K_v	g	e
Embankment fill	130	165	33	1.44 E-07	10	2.72 (ST sample)	0.609 (ST sample)
Lean Clay with Sand	119	160	24	8.62 E-07	10	2.69 (ST sample)	0.700 (ST sample)
Gravel With Silt and Sand	130	0	35	1.00 E-02	5	2.70	0.300
Sand Silt/ Silt with Sand	130	0	30	1.00 E-04	5	2.70	0.400
Bottom Ash	115	0	28	3.5E-01	1		

1. SEEPAGE ANALYSIS.

Geoslope Seep W analysis was used to analyze the model for Seepage. Field piezometer readings were compared to the model's results. The model was calibrated to approximate field water elevations.

Residual and saturated water contents and coefficients of volume compressibility were assumed for all soil layers based on previous experiences and soils' normal values.

Water elevations used were:

- Existing (normal) water elevation in the pond: 442 feet.
- Maximum possible impounded water elevation (spillway highest grate): 457.7 feet
- Ohio River water elevation 426 feet.

Seepage analysis results were used in the slope stability analysis to model pore water pressures.

2. STABILITY ANALYSIS.

Geoslope Slope W was used for the slope stability analysis.

The Spencer Analysis Method was used.

Slip circle method and siding wedge method were modeled by the circular failure plane and the block specified; the circular failure plane produced lower Factors of Safety.

The peak ground acceleration used for the seismic analysis was obtained from US Geological Survey website. The PGA used is 0.08g (USGS indicates 0.07677g). The method selected to do the seismic analysis was the pseudostatic analysis per the project scope.

Loading conditions:

Static Slope Stability Loading Conditions:

- Steady state Seepage normal pool (upstream and downstream slopes): 442 feet
- Steady state seepage maximum pool (upstream and downstream slopes): 457.7 feet
- Rapid drawdown: normal pool steady-state seepage conditions with empty pond and dredged conditions above elevation 433 feet (upstream slope)
- PMF event (upstream and downstream slopes). The flood water was considered as a surcharge and the maximum pool steady state pore pressure line was used, as the water elevation selected for the PMF event is the result of a flood occurring while the dam had the maximum water pool. PMF event water elevation in the pond is: 468.4 feet.

Seismic Slope Stability Loading Conditions:

- Steady state seepage normal pool (upstream and downstream slopes): 442 feet
- Steady state seepage maximum pool (upstream and downstream slopes): 457.7 feet

Liquefaction Assessment

To assess liquefaction potential for the WBAD, the boring logs from the geotechnical borings and laboratory test data from Shelby tubes and SPT samples were used. The boring logs include the SPT blow counts and soil lithologic descriptions with depth.

Soil characteristics (grain size, plasticity, unit weight, moisture content) from SPT and Shelby tube samples obtained from the geotechnical borings were used in the liquefaction assessment.

Method Used: Simplified Method based on using correlations to blow counts from Standard Penetration Tests (SPTs) as set forth in Youd et al (2001) and discussed in NRC (1985).

The Simplified Method requires estimating the Cyclic Stress Ratio (CSR) and Cyclic Resistance Ratio (CRR) of the soil. The CRR can be estimated using information from SPT tests, corrected to account for various effects. To use the Simplified Method, the SPT N value is normalized to an overburden pressure of approximately 100 kiloPascals (kPa) and a hammer energy ratio of 60% and procedural effects (rod length, sample configuration and borehole diameter).

The $(N_1)_{60}$ may also be corrected for the percent of fines using the relationship:

$$(N_1)_{60cs} = \alpha + \beta(N_1)_{60}$$

It is important to note that the fines correction is an approximation and is only valid for nonplastic fines and with a fines content between 0 and 35%. This correction factor, although widely used, is considered as a rough approximation only.

Once the corrected value for $(N_1)_{60}$ is found, the CRR is calculated as:

$$CRR_{7.5} = \frac{1}{34 - (N_1)_{60}} + \frac{(N_1)_{60}}{135} + \frac{50}{[10 * (N_1)_{60} + 45]^2} - \frac{1}{200}$$

Note that the value calculated is the CRR normalized to a 7.5 magnitude earthquake, hence the $CRR_{7.5}$ notation. When evaluating the liquefaction potential of soil, the $CRR_{7.5}$ must be corrected to the magnitude earthquake of interest.

The CSR is independent of soil properties and may be approximated using the equation:

$$CSR = 0.65 \left(\frac{a_{max}}{g} \right) \left(\frac{\sigma_v}{\sigma'_v} \right) r_d$$

where:

a_{max} is the maximum ground acceleration.

g is the acceleration of gravity.

σ_v is the total vertical stress.

σ'_v is the effective vertical stress.

r_d is a stress reduction coefficient.

Liquefaction potential for a soil unit is evaluated by dividing $CRR_{7.5}$ by CSR and then correcting to the magnitude earthquake of interest, as:

$$FS = \frac{CRR_{7.5} * MSF}{CSR}$$

Field experience has shown that the Simplified Method is somewhat conservative; so many designers consider FS values close to unity as an indication of no liquefaction.

B-1

Elevation	Depth	Soil class	N	Remarks
470.2	3.25	CL	11	Not liquefiable. Embankment and located above ground water
467.7	5.75	CL	10	
462.7	10.75	CL	10	
460.2	13.25	CL	7	
455.2	18.25	CL	15	
452.7	20.75	CL	15	
450.2	23.25	CL	14	
447.7	25.75	CL	8	
445.2	28.25	CL	12	
442.7	30.75	CL	11	
440.2	33.25	CL	9	
437.7	35.75	CL	10	
435.2	38.25	CL	6	
432.7	40.75	CL	5	
427.7	45.75	CL	2	Evaluated for liquefaction
425.2	48.25	CL	3	
422.7	50.75	CL	4	
420.2	53.25	CL	2	
417.7	55.75	CL	4	
415.2	58.25	CL	4	
412.7	60.75	CL	5	
410.2	63.25	CL	6	
407.7	65.75	CL	7	

B-2

Elevation	Depth	Soil class	N-field	Remarks
440.8	3.25	CL	19	Not liquefiable as layer is above ground water
438.3	5.75	CL	7	
435.8	8.25	CL	7	
430.8	13.25	CL	5	
428.3	15.75	CL	4	
425.8	18.25	CL	2	Evaluated for liquefaction
423.3	20.75	CL	4	

418.3	25.75	CL	4	
415.8	28.25	CL	9	
413.3	30.75	CL	6	
410.8	33.25	CL	6	
408.3	35.75	CL	5	
405.8	38.25	CL	4	
403.3	40.75	CL	6	
398.3	45.75	CL	2	
393.3	50.75	GW - GM	50	Not liquefiable

B-3

Elevation	Depth	Soil class	N-field	Remarks
468.4	3.25	CL	11	Not liquefiable. Embankment and located above ground water
465.9	5.75	CL	8	
463.4	8.25	CL	10	
458.4	13.25	CL	9	
455.9	15.75	CL	10	
453.4	18.25	CL	12	
448.4	23.25	CL	12	
445.9	25.75	CL	9	
443.4	28.25	CL	15	
440.9	30.75	CL	10	
438.4	33.25	CL	17	
435.9	35.75	CL	16	
433.4	38.25	CL	18	
430.9	40.75	CL	4	Evaluated for liquefaction
428.4	43.25	CL	4	
425.9	45.75	CL	6	
420.9	50.75	CL	4	
418.4	53.25	CL	2	
415.9	55.75	CL	5	
413.4	58.25	CL	2	
410.9	60.75	CL	8	
408.4	63.25	CL	6	
405.9	65.75	CL	7	
403.4	68.25	CL	9	
400.9	70.75	CL	8	

B-4

Elevation	Depth	Soil class	N-field	Remarks
443.5	3.25	CL	16	Not liquefiable as located above ground water
441.0	5.75	CL	15	
436.0	10.75	CL	11	
433.5	13.25	CL	7	
431.0	15.75	CL	5	

426.0	20.75	CL	4	Evaluated for liquefaction
424.5	22.25	CL	5	
421.0	25.75	CL	6	
418.5	28.25	CL	5	
416.0	30.75	CL	3	
413.5	33.25	CL	4	
411.0	35.75	CL	9	
406.0	40.75	CL	4	
403.5	43.25	CL	5	
401.0	45.75	CL	8	
398.5	48.25	CL	6	
396.0	50.75	CL	7	
393.5	53.25	CL	5	
391.0	55.75	CL	7	
388.5	58.25	GW - GM	39		Not liquefiable as layer is very dense
386.0	60.75	GW - GM	46	
381.5	65.25	GW - GM	50	
376.0	70.75	GW - GM	52	

B-5

Elevation	Depth	Soil class	N-field	Remarks	
465.5	3.25	CL	19	Not liquefiable.	
463.0	5.75	CL	9		
458.0	10.75	CL	15		
455.5	13.25	CL	10		
453.0	15.75	CL	7		
450.5	18.25	CL	16		
448.0	20.75	CL	7		
443.0	25.75	CL	8		
440.5	28.25	CL	7		
438.0	30.75	CL	12		
435.5	33.25	CL	8		
433.0	35.75	CL	16		
430.5	38.25	CL	6		
428.0	40.75	CL	3		Evaluated for liquefaction
423.0	45.75	CL	4		
420.5	48.25	ML	4	Evaluated for liquefaction	
418.0	50.75	ML	6		
415.5	53.25	ML	2		
413.0	55.75	ML	4		
410.5	58.25	ML	5		
408.0	60.75	ML	7		
405.5	63.25	ML	9		
403.0	65.75	ML	11		
400.5	68.25	ML	9		
398.0	70.75	ML	13		

B-6

Elevation	Depth	Soil class	N-field	Remarks
442.3	3.25	CL	8	Not liquefiable as layer is above ground water
439.8	5.75	CL	10	
434.8	10.75	CL	18	
432.3	13.25	CL	4	
429.8	15.75	CL	3	
424.8	20.75	CL	1	
422.3	23.25	CL	2	Evaluated for liquefaction
419.8	25.75	CL	4	
417.3	28.25	ML	5	
414.8	30.75	ML	3	Evaluated for liquefaction
412.3	33.25	ML	3	
409.8	35.75	ML	1	
407.3	38.25	ML	1	
402.3	43.25	ML	2	
399.8	45.75	ML	1	
397.3	48.25	ML	1	
394.8	50.75	ML	5	
392.3	53.25	ML	11	
389.8	55.75	ML	4	
387.3	58.25	ML	9	
384.8	60.75	ML	11	
379.8	65.75	ML	9	
374.8	70.75	ML	10	

TABLE 1
Typical Properties of Compacted Soils

Group Symbol	Soil Type	Range of Maximum Dry Unit Weight, pcf	Range of Optimum Moisture, Percent	Typical Value of Compression		Typical Strength Characteristics				Typical Coefficient of Permeability ft./min.	Range of CBR Values	Range of Subgrade Modulus k lbs/cu in.
				At 1.4 tsf (20 psf)	At 3.6 tsf (50 psf)	Cohesion (as compacted) paf	Cohesion (saturated) paf	ϕ (Effective Stress Envelope Degrees)	Tan ϕ			
GW	Well graded clean gravels, gravel-sand mixtures.	125 - 135	11 - 8	0.3	0.6	0	0	>38	>0.79	5×10^{-2}	40 - 80	300 - 500
GP	Poorly graded clean gravels, gravel-sand mix	115 - 125	14 - 11	0.4	0.9	0	0	>37	>0.74	10^{-1}	30 - 60	250 - 400
GN	Silty gravels, poorly graded gravel-sand-silt.	120 - 135	12 - 8	0.5	1.1	.....	.....	>34	>0.67	$>10^{-4}$	20 - 60	100 - 400
GC	Clayey gravels, poorly graded gravel-sand-clay.	115 - 130	14 - 9	0.7	1.6	.....	.....	>31	>0.60	$>10^{-7}$	20 - 40	100 - 300
SW	Well graded clean sands, gravelly sands.	110 - 130	16 - 9	0.6	1.2	0	0	38	0.79	$>10^{-3}$	20 - 40	200 - 300
SP	Poorly graded clean sands, sand-gravel mix.	100 - 120	21 - 12	0.8	1.4	0	0	37	0.74	$>10^{-3}$	10 - 40	200 - 300
SM	Silty sands, poorly graded sand-silt mix.	110 - 125	16 - 11	0.8	1.6	1050	420	34	0.67	5×10^{-5}	10 - 40	100 - 300
SM-SC	Sand-silt clay mix with slightly plastic fines.	110 - 130	15 - 11	0.8	1.4	1050	300	33	0.66	2×10^{-6}	5 - 30	100 - 300
SC	Clayey sands, poorly graded sand-clay-mix.	105 - 125	19 - 11	1.1	2.2	1550	230	31	0.60	5×10^{-7}	5 - 20	100 - 300
ML	Inorganic silts and clayey silts.	95 - 120	24 - 12	0.9	1.7	1400	190	32	0.62	$>10^{-5}$	15 or less	100 - 200
ML-CL	Mixture of inorganic silt and clay.	100 - 120	22 - 12	1.0	2.2	1350	460	32	0.62	5×10^{-7}	.....
CL	Inorganic clays of low to medium plasticity.	95 - 120	24 - 12	1.3	2.5	1800	270	28	0.54	$>10^{-7}$	15 or less	50 - 200
OL	Organic silts and silt-clays, low plasticity.	80 - 100	33 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	50 - 100
MI	Inorganic clayey silts, elastic silts.	70 - 95	40 - 24	2.0	3.8	1500	420	25	0.47	5×10^{-7}	10 or less	50 - 100
CI	Inorganic clays of high plasticity	75 - 105	36 - 19	2.6	3.9	2150	230	19	0.35	$>10^{-7}$	15 or less	50 - 150
OH	Organic clays and silty clays	65 - 100	45 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	25 - 100

Notes:

- All properties are for condition of "Standard Proctor" maximum density, except values of k and CBR which are for "modified Proctor" maximum density.
- Typical strength characteristics are for effective strength envelopes and are obtained from USSR data.
- Compression values are for vertical loading with complete lateral confinement.
- (>) indicates that typical property is greater than the value shown.
(..) indicates insufficient data available for an estimate.

7.2-39

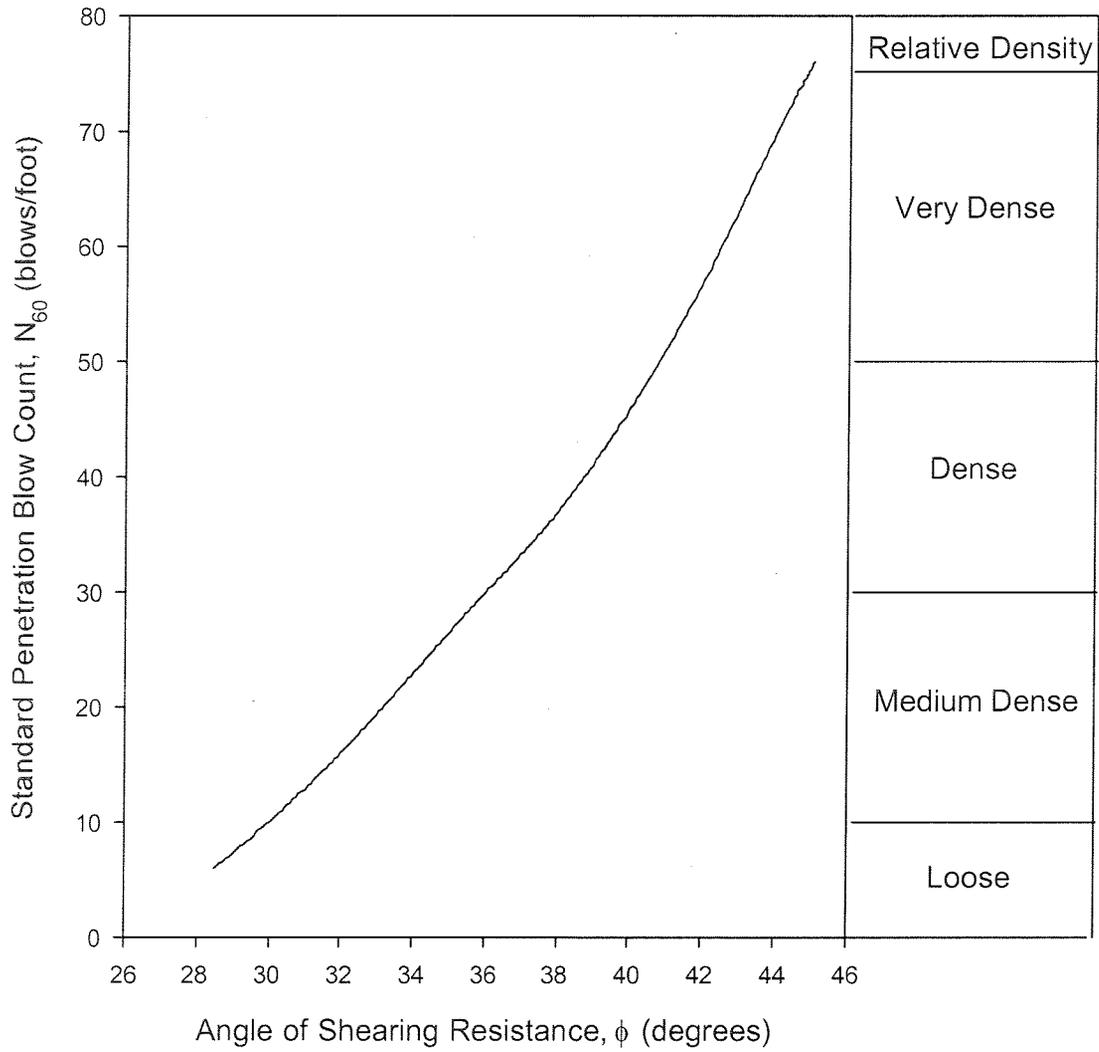


Figure 35. Estimation of the angle of shearing resistance of granular soils from standard penetration test results (Originally from Peck et al., 1974, modified by Carter and Bentley, 1991).

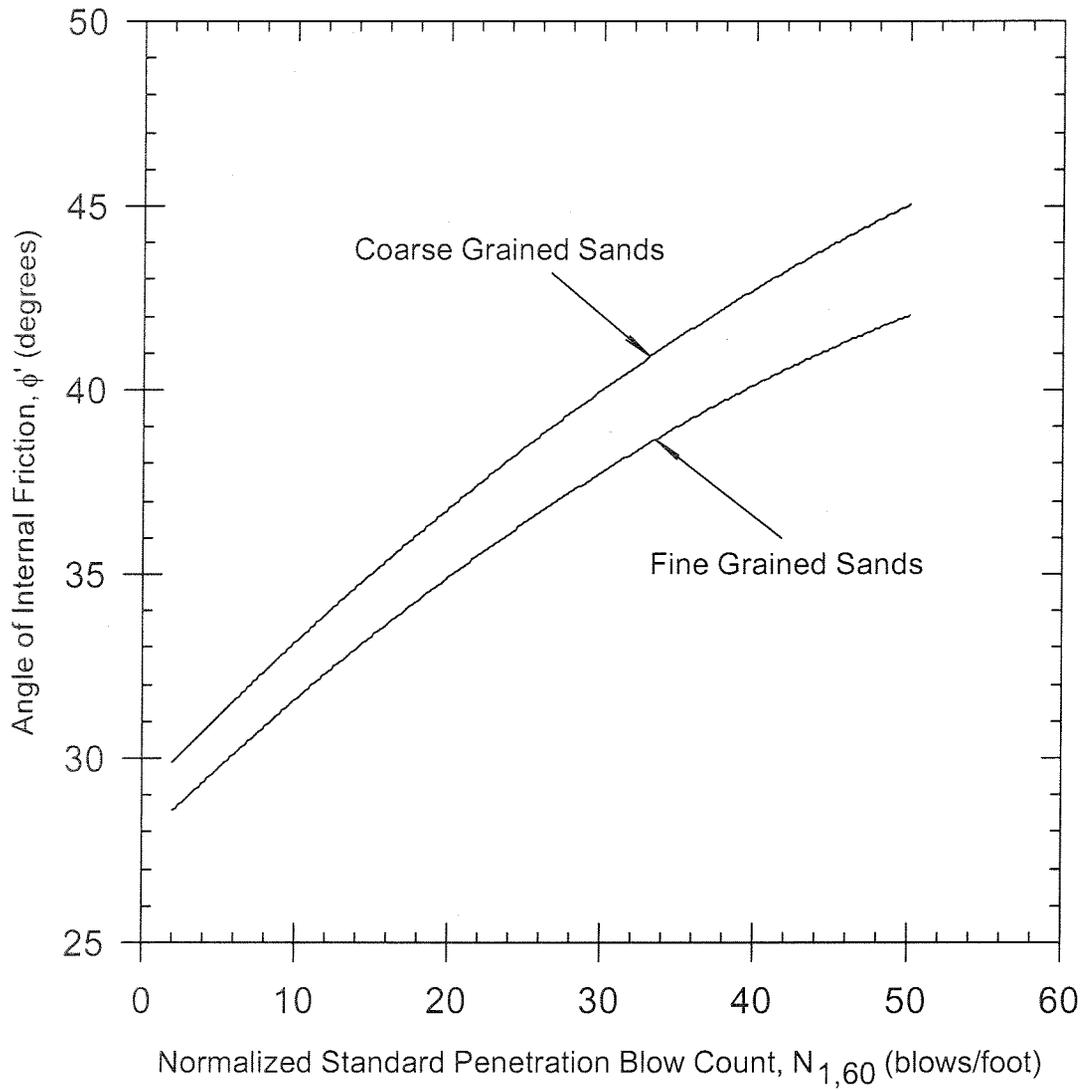


Figure 34. Empirical correlation between friction angle of sands and normalized standard penetration blow count (after Terzaghi et al., 1996)

WBAP Trench Testing (Bottom Ash Testing)

ASTM D 422, C 136

Sample	Classification	ø (%)	D ₁₀ (mm)	D ₃₀ (mm)	D ₆₀ (mm)	Cu	Cc	Sieve Size (% Passing)								Pan	% Gravel	% Sand	% Fines	K(cm/s)	Fines 200 C	Fines Classification
								3" 75	1 1/2" 37.5	1" 25.0	3/4" 19.0	3/8" 9.5	No. 4 4.75	No. 10 2	No. 40 0.425								No. 200 0.075
1	Well Graded Sand (SW) with Gravel	6.2	0.3798	1.1724	3.2161	8.47	1.13	100.0	100.0	96.9	95.0	84.8	74.1	42.9	11.8	1.8	0.0	25.9	72.2	1.7	4.1E-01	
2	Poorly Graded Sand (SP) with Gravel	5.6	0.5766	1.4565	3.4443	5.97	1.07	100.0	100.0	96.1	93.8	85.2	72.9	38.2	5.5	0.8	0.0	27.1	72.1	0.8	1.1E+00	
3	Well Graded Sand (SW)	7.5	0.3386	0.9936	2.6258	7.76	1.11	100.0	100.0	100.0	100.0	95.1	85.9	50.4	12.2	2.2	0.0	14.1	83.8	1.9	3.0E-01	
4	Poorly Graded Sand (SP) with Gravel	5.9	0.5081	1.2732	3.0405	5.98	1.05	100.0	100.0	100.0	95.9	89.7	78.9	42.5	7.3	1.3	0.0	21.1	77.6	1.2	5.9E-01	
5	Poorly Graded Sand (SP) with Gravel	6.0	0.5210	1.2514	2.9512	5.66	1.02	100.0	100.0	100.0	98.7	91.7	80.6	43.7	6.5	1.2	0.0	19.4	79.5	1.1	8.4E-01	
6	Well Graded Sand (SW) with Gravel	7.1	0.3792	1.0490	2.7409	7.23	1.06	100.0	100.0	97.7	94.4	90.1	81.6	47.6	11.0	2.2	0.0	18.4	79.3	2.1	3.6E-01	
7	Poorly Graded Sand (SP-SC) with Clay	23.1	0.0757	0.1599	0.5429	7.17	0.62	100.0	100.0	100.0	100.0	98.4	94.7	80.6	56.1	9.8	0.0	5.3	84.9	10.0	5.6E-02	
8	Well Graded Sand with Gravel (SW), gray	8.7	0.1868	0.8464	2.6959	14.44	1.42	100.0	100.0	100.0	99.5	94.8	84.4	47.1	17.1	2.1	0.0	15.6	82.4	2.1	3.0E-01	
9	Well Graded Sand (SW) with Gravel	5.4	0.3714	1.4341	3.9659	10.68	1.40	100.0	100.0	93.7	89.1	77.9	66.1	36.5	11.3	1.0	0.0	33.9	65.1	1.0	2.9E-01	
10	Well Graded Sand (SW) with Gravel	4.4	0.2954	1.3526	4.3012	14.56	1.44	100.0	100.0	94.8	87.9	76.3	63.1	36.3	12.3	1.4	0.0	36.9	61.7	1.4	1.7E-01	
11	Well Graded Sand (SW) with Gravel	4.4	0.3771	1.1624	3.2364	8.58	1.11	100.0	100.0	100.0	96.3	87.8	75.2	41.0	10.6	1.8	0.0	24.8	73.3	1.8	3.9E-01	
12	Poorly Graded Sand (SP) with Gravel	2.7	0.4552	1.1566	3.1130	6.84	0.94	100.0	100.0	97.9	96.4	86.8	76.9	42.4	8.5	1.4	0.0	23.1	75.5	1.4	4.7E-01	
13	Well Graded Sand (SW) with Gravel	12.5	0.1642	0.7368	2.4777	15.09	1.33	100.0	100.0	100.0	100.0	93.1	84.1	53.4	20.4	3.7	0.0	15.9	80.4	3.7	2.4E-01	
14	Well Graded Sand (SW-SC) with Clay and Gravel	14.0	0.1021	0.9001	3.1464	30.82	2.52	100.0	90.3	90.3	89.1	84.2	75.4	44.5	20.0	7.8	0.0	24.6	67.6	7.8	2.5E-01	CH
15		7.7	0.1110	0.6950	2.4690	22.24	1.76	100.0	100.0	100.0	99.1	93.7	83.3	53.8	21.7	6.6	0.0	16.7	76.7	6.6		
16		8.4	0.0934	0.6601	2.3445	25.10	1.99	100.0	100.0	100.0	100.0	95.3	86.1	54.9	22.4	8.4	0.0	13.9	77.7	8.4		
17		6.8	0.1413	0.7713	2.6062	18.44	1.62	100.0	100.0	100.0	98.3	93.1	81.3	51.6	20.1	6.1	0.0	18.7	75.2	6.1		
18	Silty Sand (SM), with Gravel	8.5						100.0	100.0	94.4	91.5	85.3	76.4	49.5	46.6	33.3	0.0	23.6	43.1	33.3	8.6E-02	
19		8.2	0.1425	0.7675	2.6682	18.72	1.55	100.0	100.0	100.0	98.5	90.6	81.2	50.8	19.8	6.1	0.0	18.8	75.1	6.1		
20	Silty Sand (SM), gray	13.3						100.0	100.0	100.0	100.0	94.3	87.5	61.4	30.9	14.3	0.0	12.5	73.2	14.3	1.9E-02	
21	Silty Sand (SM), gray	16.8						100.0	100.0	100.0	100.0	96.5	89.5	62.2	34.4	17.1	0.0	10.5	72.4	17.1	1.8E-02	
22	Well Graded Sand (SW-SM) with Silt and Gravel	5.8	0.1552	1.0052	2.9060	18.73	2.24	100.0	100.0	100.0	97.1	93.3	84.0	43.5	18.6	5.6	0.0	16.0	78.4	5.6		ML
23	Well Graded Sand (SW-SM) with Silt and Gravel	6.8	0.1053	0.6226	2.6016	24.71	1.42	100.0	100.0	100.0	97.0	89.4	81.0	52.3	23.5	6.7	0.0	19.0	74.3	6.7		ML
24	Well Graded Sand (SW-SM) with Silt	4.5	0.1541	0.8266	2.6141	16.96	1.70	100.0	100.0	100.0	97.7	92.9	86.8	49.2	19.4	5.3	0.0	13.2	81.5	5.3		ML
25	Well Graded Sand (SW-SM) with Silt and Gravel	6.8	0.0972	0.5461	2.4056	24.74	1.28	100.0	100.0	98.4	96.7	90.2	81.0	54.5	26.1	7.2	0.0	19.0	73.8	7.2		ML
		<i>max</i>	0.5766	1.4565	4.3012	30.82	2.52	100.0	100.0	100.0	100.0	98.4	94.7	80.6	56.1	33.3	0.0	36.9	84.9	33.3	1.1E+00	
		<i>min</i>	0.0757	0.1599	0.5429	5.66	0.62	100.0	90.3	90.3	87.9	76.3	63.1	36.3	5.5	0.8	0.0	5.3	43.1	0.8	1.8E-02	
		<i>average</i>	0.2605	0.9472	2.8233	14.50	1.40	100.0	99.6	98.4	96.5	90.0	80.5	49.2	19.8	6.2	0.0	19.5	74.3	6.2	3.5E-01	

LANDFILL RUNOFF COLLECTION POND

FLY ASH DAM GEOTECHNICAL ANALYSIS

PARAMETER DERIVATION

I. Subsurface Exploration Program Development:

The scope determined two sections across the dam. Two borings will be drilled on each section, on the crest and at the toe, only Sheby tube samples were collected that will be used to supplement available historic borings data in the development of the soil profile.

II. Laboratory Testing Program:

The program was developed to provide additional soil data to available historic data.

- USCS Soil Classification Tests.
- Triaxial tests.
- Permeability tests
- Moisture-density tests.

III. Geotechnical Analysis:

A soil tests summary was developed to select soil parameters to use in the geotechnical analysis. Engineering properties that were not directly tested were determined using typical soil parameter values from NAVFAC DM7-02 Foundations and Earth Structures (Table 1 on Page 39) and the Center For Geotechnical Practice and Research, Performance and Use of the Standard Penetration Test in Geotechnical Engineering Practice report (Figures 34 and 35 on pages 72 and 77 respectively). The two tables are attached at the end of the parameter derivation notes.

Permeability k values that were not tested in the laboratory were selected from typical values provided in the table below and those provided in NAVFAC DM7.02, table 1: Typical Properties of Compacted soils

Soil Type	k_v (cm/s)
Coarse Sand	$>10^{-1}$
Fine Sand	10^{-1} to 10^{-3}
Silty Sand	10^{-3} to 10^{-5}
Silt	10^{-5} to 10^{-7}
Clay	$<10^{-7}$

Historic boring and graphic logs were used to develop the dam's soil horizons for soil layers on which soil sampling was not done.

Soils from the Fly Ash Dam were classified into 7 main soil layers.

The following table shows how pertinent parameters were selected and which sections they were applied to.

Soil name	USGS class	Classification Samples	Shear results sample	Permeability k-value sample	Section
Embankment fill	CL	B-9 sample (20.2' – 20.8')	Average Triaxial Test B-7 & B-9	Average K tests B-7 & B-9	D/E
Lean Clay With Sand	CL	B-8 sample (25.5' – 25.8')	Average Triaxial Test B-8 & B-10	Permeability test B-8	D/E
Clayey Sand and Gravel	GC	Fly Ash Dam Raising report logs	Typical values *	Typical values *	D
Sandy Silts	ML	Fly Ash Dam Raising report logs	Typical values *	Typical values *	D
Silty Clay With Sand	CL-ML	B-10 sample (16.2' – 16.8')	Typical values *	Permeability test B-10	E
Silty Sand	SM	B-10 sample (14.2' – 14.8')	Typical values *	Typical values *	D/E
Fly Ash	NA	NA	Typical values *	Hydrogeologic study report	D/E

* Typical values as determined from referenced tables.

Soil name	Unit Weight	C	ϕ	kv (cm/sec)	Typical kh/kv	g	e
Embankment fill	129	198	27.5	7.30E-08	10	2.63 B-7 (27.2-27.8)	0.609 (ST sample)
Lean Clay With Sand	127	205.92	28	3.40E-08	10	2.65 B-8 (29.7-30.3)	0.700 (ST sample)
Clayey Sand and Gravel	130	0	35	1.00E-02	10	2.70	0.5
Sandy Silts	125	0	30	1.00E-04	5	2.65 B-8 (29.7-30.3)	0.4
Silty Clay With Sand	118	151.92	34.1	1.40E-07	10	2.68 B-10 (14.2-14.8)	0.43

Silty Sand	94	0	30	1.00E-04	5	2.66 B-10 (16.2- 16.8)	0.4
Fly Ash	115	0	25	4.75E-04	50	NA	NA

1. SEEPAGE ANALYSIS.

Geoslope Seep W analysis was used to analyze the model for seepage. Historic Field piezometer readings (Hydrogeologic Study Report, Clifty Creek Coal Ash Landfill, AGES. November 2006) were compared to the model's results. The model results were inconsistent with available piezometer readings. This was due to a lack of enough soil property data.

Water elevations used were:

- Existing (normal) water elevation in the pond: 485 feet.
- Ohio River water elevation 426 feet.

Seepage analysis results were not used in slope stability analyses.

2. STABILITY ANALYSIS.

Geoslope Slope W was used for the slope stability analysis.

The Spencer Analysis Method was used.

Slip circle method and siding wedge method were modeled by the circular failure plane and the block specified; the circular failure plane produced lower Factors of Safety.

The peak ground acceleration used for the seismic analysis was obtained from US Geological Survey website. The PGA used is 0.08g. The method selected to do the seismic analysis was the pseudostatic analysis per the project scope.

Loading conditions:

During a period from 2004 to 2006, groundwater readings from different piezometers and wells across the dam and toe area were taken. The results of these readings provide were used for steady state analysis. (Hydrogeologic Study Report, Clifty Creek Coal Ash Landfill, AGES. November 2006)

Static Slope Stability Loading Conditions:

- Steady state Seepage normal pool (upstream and downstream slopes): 485 feet
- PMF event (upstream and downstream slopes). The flood water was considered as a surcharge above the water pool for steady state. PMF event water elevation in the pond: 501.4 feet.

Seismic Slope Stability Loading Conditions:

- Steady state seepage normal pool (upstream and downstream slopes): 485 feet.

3. LIQUEFACTION ANALYSIS.

Research and methodology:

- Earthquake intensity: USGS website used to determine the Peak Ground Acceleration and earthquake intensity for an earthquake event of a mean return period of 2,475 years. $PGA = 0.07677g$ (used $0.08g$) and $M_L = 7.7$.
- Groundwater elevation data from 2004 through 2006 provide a steady state water elevation through the dam and the foundation soil materials. Unsaturated soil located above the groundwater table will not liquefy.
- Soil Type:

The dam soil materials, being constructed of engineered fill are not considered liquefiable.

Cohesionless materials are considered liquefiable. The majority of cohesive soils will not liquefy, cohesive soils susceptible to liquefy should have an liquid limit less than 37 and the water content of the soil must be greater than about 85% of the liquid limit.

Due to the absence of USCS classification laboratory results, cohesive foundation materials were considered potentially liquefiable and Factors of Safety against liquefaction were calculated.

- Soil relative density (D_r): Soils in a loose relative density state are susceptible to liquefaction. Soils with an SPT-N value of 30 or higher were considered not liquefiable.

Liquefaction Assessment

Data from nine historical borings (SI-1, SS1-1, SS2-1, SS2-4, SS3-1, SS3-4, SS4-1, SS4-4, and SS5-1) were used to assess liquefaction potential. These borings were drilled in 1984 as part of the AEP Fly Ash Dam Raising Feasibility Project (1985). Soil characteristics included on the borings include the visually-estimated soil classifications per the USCS and SPT N-values.

In order to analyze the dam and foundation materials against liquefaction, it was necessary to assume the percent fines, or percent silt and clay, for many of the soils due to lack of particle size distribution data for the historic borings. Correlating current laboratory classification results with historic logs was done and where data was not available, typical values were assumed based on the visual USCS classifications on the historical boring logs.

Method Used: Simplified Method based on using correlations to blow counts from Standard Penetration Tests (SPTs) as set forth in Youd et al (2001) and discussed in NRC (1985).

The Simplified Method requires estimating the Cyclic Stress Ratio (CSR) and Cyclic Resistance Ratio (CRR) of the soil. The CRR can be estimated using information from SPT tests, corrected to account for various effects. To use the Simplified Method, the SPT N value is normalized to an overburden pressure of approximately 100 kiloPascals (kPa) and a hammer energy ratio of 60% and procedural effects (rod length, sample configuration and borehole diameter).

The $(N_1)_{60}$ may also be corrected for the percent of fines using the relationship:

$$(N_1)_{60cs} = \alpha + \beta(N_1)_{60}$$

It is important to note that the fines correction is an approximation and is only valid for nonplastic fines and with a fines content between 0 and 35%. This correction factor, although widely used, is considered as a rough approximation only.

Once the corrected value for $(N_1)_{60}$ is found, the CRR is calculated as:

$$CRR_{7.5} = \frac{1}{34 - (N_1)_{60}} + \frac{(N_1)_{60}}{135} + \frac{50}{[10 * (N_1)_{60} + 45]^2} - \frac{1}{200}$$

Note that the value calculated is the CRR normalized to a 7.5 magnitude earthquake, hence the $CRR_{7.5}$ notation. When evaluating the liquefaction potential of soil, the $CRR_{7.5}$ must be corrected to the magnitude earthquake of interest.

The CSR is independent of soil properties and may be approximated using the equation:

$$CSR = 0.65 \left(\frac{a_{max}}{g} \right) \left(\frac{\sigma_v}{\sigma'_v} \right) r_d$$

where:

a_{max} is the maximum ground acceleration.

g is the acceleration of gravity.

σ_v is the total vertical stress.

σ'_v is the effective vertical stress.

r_d is a stress reduction coefficient.

Liquefaction potential for a soil unit is evaluated by dividing $CRR_{7.5}$ by CSR and then correcting to the magnitude earthquake of interest, as:

$$FS = \frac{CRR_{7.5}}{CSR} * MSF$$

Field experience has shown that the Simplified Method is somewhat conservative; so many designers consider FS values close to unity as an indication of no liquefaction.

SI-1

Elevation	Depth	Soil class	N	Remarks
452.8	3.75	SC	16	Not liquefiable, above ground water.
447.8	8.75	SC	13	
442.8	13.75	ML	8	
437.8	18.75	ML	5	Evaluated for liquefaction
432.8	23.75	ML	9	
427.8	28.75	SC	23	
422.8	33.75	SC	24	
417.8	38.75	SM	22	
412.8	43.75	ML	18	
407.8	48.75	ML	28	
402.8	53.75	ML	22	
397.8	58.75	ML	12	
392.8	63.75	ML	9	
387.8	68.75	ML	14	
382.8	73.75	ML	21	
377.8	78.75	ML	50	

SS1-1

Elevation	Depth	Soil class	N-field	Remarks
502.3	3.25	CL	17	Not liquefiable Embankment as layer is above ground water
497.3	8.25	CL	12	
492.3	13.25	CL	17	
487.3	18.25	CL	15	
482.3	23.25	CL-ML	17	
477.3	28.25	CL	15	
472.3	33.25	CL	21	
467.3	38.25	CL	23	
462.3	43.25	ML	30	
457.3	48.25	ML	24	
452.3	53.25	CL	23	Evaluated for liquefaction
447.3	58.25	CL	35	
442.3	63.25	CL	27	
437.3	68.25	SC	8	
432.3	73.25	CL	20	
427.3	78.25	CL	24	
422.3	83.25	CL	30	
417.3	88.25	SC	46	

SS2-1

Elevation	Depth	Soil class	N-field	Remarks
500.7	3.75	CL	10	Not liquefiable. Embankment and located above ground water
495.7	8.75	CL	12	
490.7	13.75	CL	13	
485.7	18.75	CL-ML	26	
480.7	23.75	CL	14	
475.7	28.75	CL	17	
470.7	33.75	CL	24	
465.7	38.75	CL	25	
460.7	43.75	CL	13	
455.7	48.75	CL	14		Evaluated for liquefaction
450.7	53.75	CL	24	
445.7	58.75	CL	26	
440.7	63.75	ML	26	
435.7	68.75	CL	13	
430.7	73.75	SM	12	
425.7	78.75	SM	43	
420.7	83.75	SM	28	
415.7	88.75	CL	22	
410.7	93.75	CL	29	

SS2-4

Elevation	Depth	Soil class	N-field	Remarks
436.6	3.25	CL	13	Evaluated for liquefaction
431.6	8.25	CL	12	
426.6	13.25	CL	8	
421.6	18.25	SM	12	
416.6	23.25	CL	6	
411.6	28.25	CL	17	
406.6	33.25	CL	17	
401.6	38.25	CL	15	
396.6	43.25	CL	11	
391.6	48.25	CL	12	
386.6	53.25	CL	13	
381.6	58.25	CL	19	
376.6	63.25	GC	22	

SS3-1

Elevation	Depth	Soil class	N-field	Remarks
501.2	3.25	CL	11	Not liquefiable. Embankment and located above ground water
496.2	8.25	CL-ML	12	
491.2	13.25	CL	22	
486.2	18.25	ML	17	
481.2	23.25	CL	22	Evaluated for liquefaction
476.2	28.25	SC	27	
471.2	33.25	CL	10	
466.2	38.25	ML	15	
461.2	43.25	ML	22	
456.2	48.25	SP	24	
451.2	53.25	SC	33	
446.2	58.25	SP	17	
441.2	63.25	SP	20	
436.2	68.25	SM	25	
431.2	73.25	SP	14	
426.2	78.25	SP	37	
421.2	83.25	SP	28	
416.2	88.25	SM	29	
411.2	93.25	SM	28	
406.2	98.25	CL	29	

SS3-4

Elevation	Depth	Soil class	N-field	Remarks
448.1	3.75	CL	10	Not liquefiable, above ground water
443.1	8.75	CL	11	
438.1	13.75	SM	5	Evaluated for liquefaction
433.1	18.75	SM	7	
428.1	23.75	SC	2	
423.1	28.75	ML	11	
418.1	33.75	ML	9	
413.1	38.75	CL	2	
408.1	43.75	CL	19	
403.1	48.75	CL	22	
398.1	53.75	CL	15	
393.1	58.75	CL	16	
388.1	63.75	CL	19	
383.1	68.75	CL	21	
378.1	73.75	CL	20	
373.1	78.75	CL	34	

SS4-1

Elevation	Depth	Soil class	N-field	Remarks
502.4	3.25	CL	5	Not liquefiable. Embankment and above ground water
497.4	8.25	ML	23	
492.4	13.25	CL	13	
487.4	18.25	CL	24	
482.4	23.25	CL	17	
477.4	28.25	CL	19	
472.4	33.25	CL	20	
467.4	38.25	CL	16	Evaluated for liquefaction
462.4	43.25	ML	17	
457.4	48.25	SM	11	
452.4	53.25	SM	23	
447.4	58.25	SM	18	
442.4	63.25	SM	24	
437.4	68.25	CL	26	
432.4	73.25	SC	5	
427.4	78.25	ML	22	
422.4	83.25	ML	29	
417.4	88.25	ML	30	
412.4	93.25	ML	30	

SS4-4

Elevation	Depth	Soil class	N-field	Remarks
447.0	3.75	CL	13	Not liquefiable, above ground water
442.0	8.75	CL	7	
437.0	13.75	SM	2	Evaluated for liquefaction
432.0	18.75	CL	4	
427.0	23.75	GC	50	
422.0	28.75	GC	29	

SS5-1

Elevation	Depth	Soil class	N-field	Remarks
501.6	3.25	CL	8	Not liquefiable, Embankment and above ground water
496.6	8.25	CL	20	
491.6	13.25	CL	20	
486.6	18.25	SC	22	
481.6	23.25	SM	25	
476.6	28.25	SM	50	N-values more than 30.
471.6	33.25	SM	50	
466.6	38.25	SM	50	

TABLE 1
Typical Properties of Compacted Soils

Group Symbol	Soil Type	Range of Maximum Dry Unit Weight, pcf	Range of Optimum Moisture, Percent	Typical Value of Compression		Typical Strength Characteristics				Typical Coefficient of Permeability ft./min.	Range of CBR Values	Range of Subgrade Modulus k lbs/cu in.
				At 1.4 tsf (20 psf)	At 3.6 tsf (50 psf)	Cohesion (as compacted) paf	Cohesion (saturated) paf	ϕ (Effective Stress Envelope Degree)	Tan ϕ			
GW	Well graded clean gravels, gravel-sand mixtures.	125 - 135	11 - 8	0.3	0.6	0	0	>38	>0.79	5×10^{-2}	40 - 80	300 - 500
GP	Poorly graded clean gravels, gravel-sand mix	115 - 125	14 - 11	0.4	0.9	0	0	>37	>0.74	10^{-1}	30 - 60	250 - 400
GN	Silty gravels, poorly graded gravel-sand-silt.	120 - 135	12 - 8	0.5	1.1	.....	.....	>34	>0.67	$>10^{-4}$	20 - 60	100 - 400
GC	Clayey gravels, poorly graded gravel-sand-clay.	115 - 130	14 - 9	0.7	1.6	.....	.....	>31	>0.60	$>10^{-7}$	20 - 40	100 - 300
SW	Well graded clean sands, gravelly sands.	110 - 130	16 - 9	0.6	1.2	0	0	38	0.79	$>10^{-3}$	20 - 40	200 - 300
SP	Poorly graded clean sands, sand-gravel mix.	100 - 120	21 - 12	0.8	1.4	0	0	37	0.74	$>10^{-3}$	10 - 40	200 - 300
SM	Silty sands, poorly graded sand-silt mix.	110 - 125	16 - 11	0.8	1.6	1050	420	34	0.67	$5 \times >10^{-5}$	10 - 40	100 - 300
SM-SC	Sand-silt clay mix with slightly plastic fines.	110 - 130	15 - 11	0.8	1.4	1050	300	33	0.66	$2 \times >10^{-6}$	5 - 30	100 - 300
SC	Clayey sands, poorly graded sand-clay-mix.	105 - 125	19 - 11	1.1	2.2	1550	230	31	0.60	$5 \times >10^{-7}$	5 - 20	100 - 300
ML	Inorganic silts and clayey silts.	95 - 120	24 - 12	0.9	1.7	1400	190	32	0.62	$>10^{-5}$	15 or less	100 - 200
ML-CL	Mixture of inorganic silt and clay.	100 - 120	22 - 12	1.0	2.2	1350	460	32	0.62	$5 \times >10^{-7}$	.....
CL	Inorganic clays of low to medium plasticity.	95 - 120	24 - 12	1.3	2.5	1800	270	28	0.54	$>10^{-7}$	15 or less	50 - 200
OL	Organic silts and silt-clays, low plasticity.	80 - 100	33 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	50 - 100
MI	Inorganic clayey silts, elastic silts.	70 - 95	40 - 24	2.0	3.8	1500	420	25	0.47	$5 \times >10^{-7}$	10 or less	50 - 100
CI	Inorganic clays of high plasticity	75 - 105	36 - 19	2.6	3.9	2150	230	19	0.35	$>10^{-7}$	15 or less	50 - 150
OH	Organic clays and silty clays	65 - 100	45 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	25 - 100

Notes:

- All properties are for condition of "Standard Proctor" maximum density, except values of k and CBR which are for "modified Proctor" maximum density.
- Typical strength characteristics are for effective strength envelopes and are obtained from USSR data.
- Compression values are for vertical loading with complete lateral confinement.
- (>) indicates that typical property is greater than the value shown.
(..) indicates insufficient data available for an estimate.

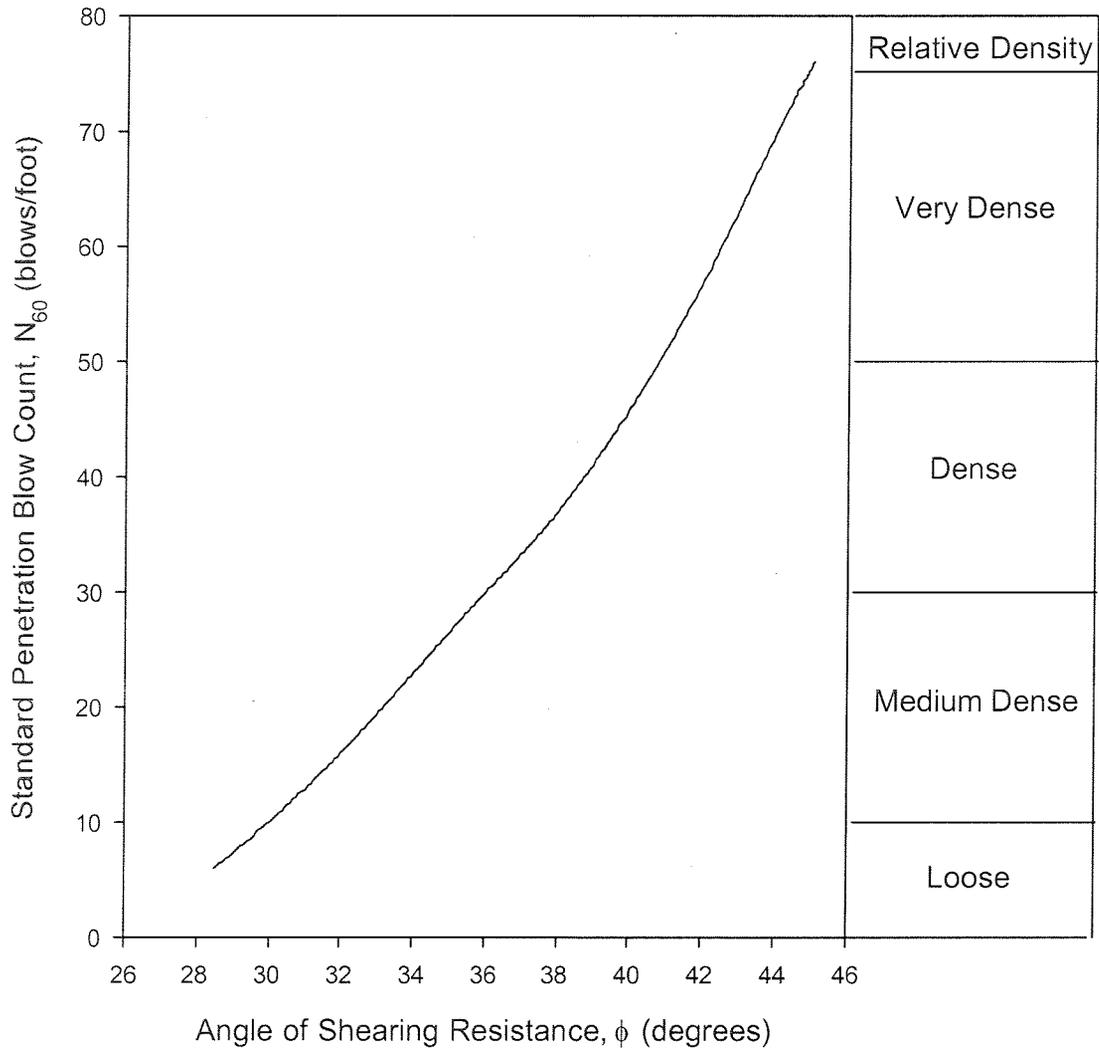


Figure 35. Estimation of the angle of shearing resistance of granular soils from standard penetration test results (Originally from Peck et al., 1974, modified by Carter and Bentley, 1991).

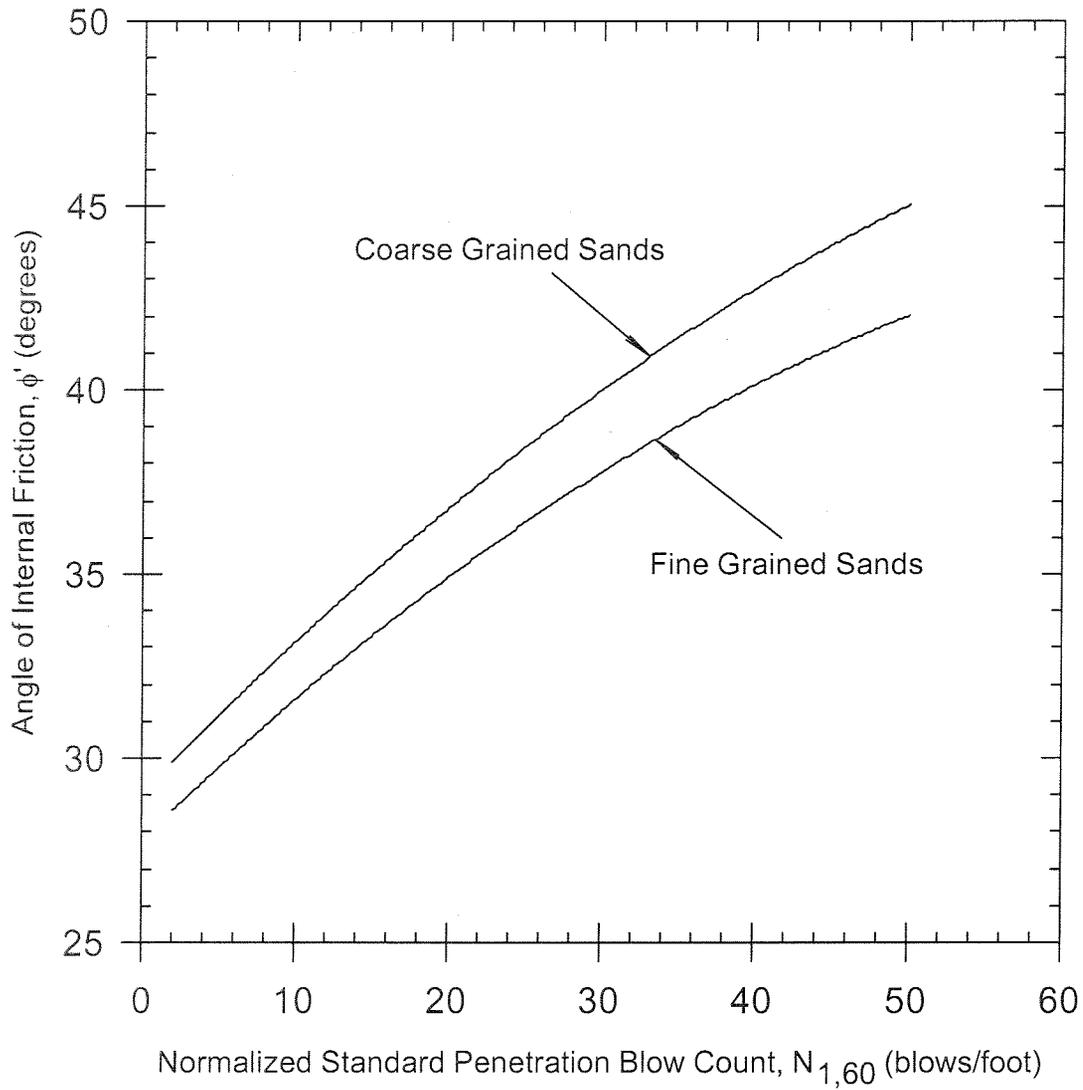
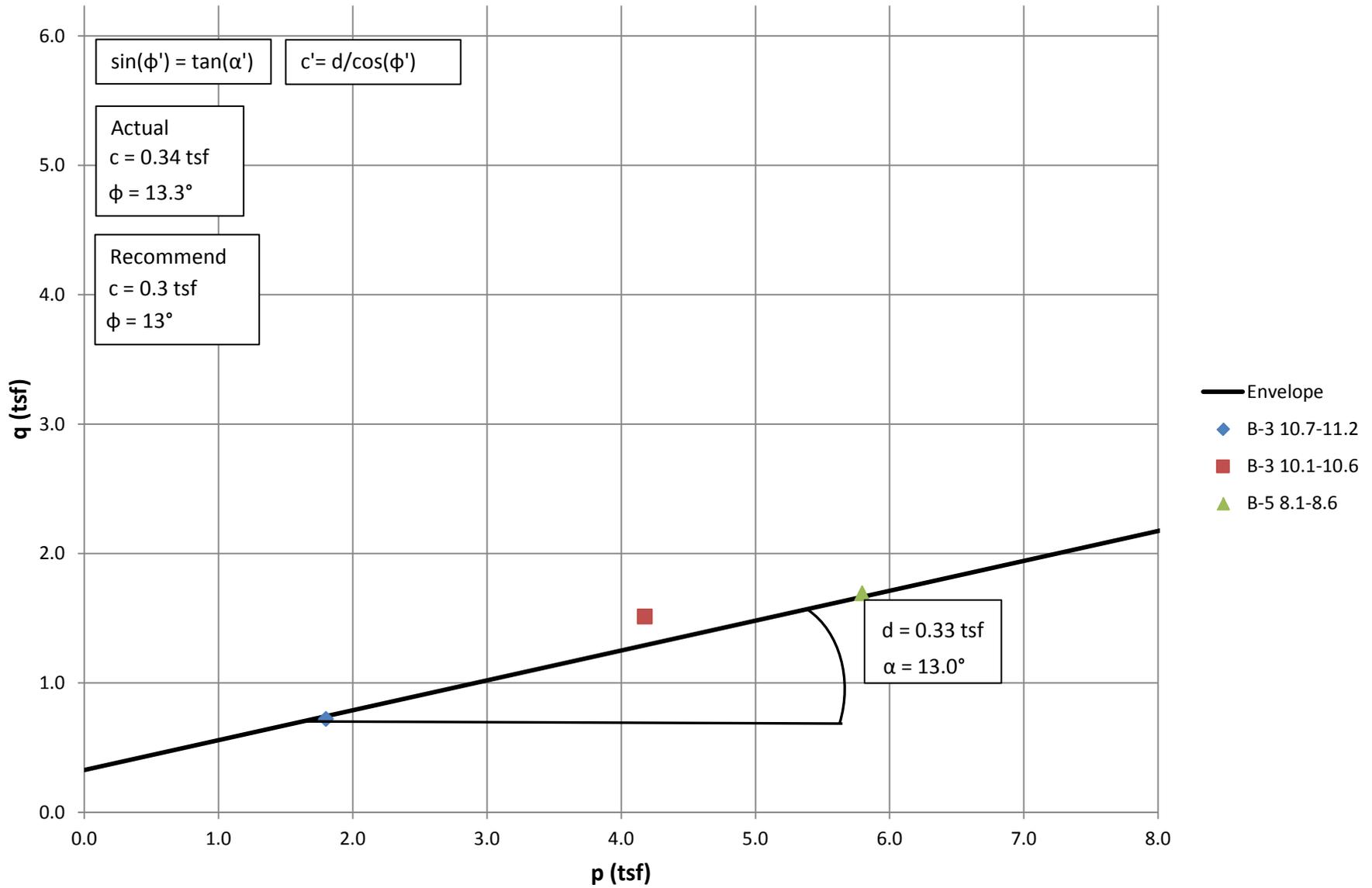


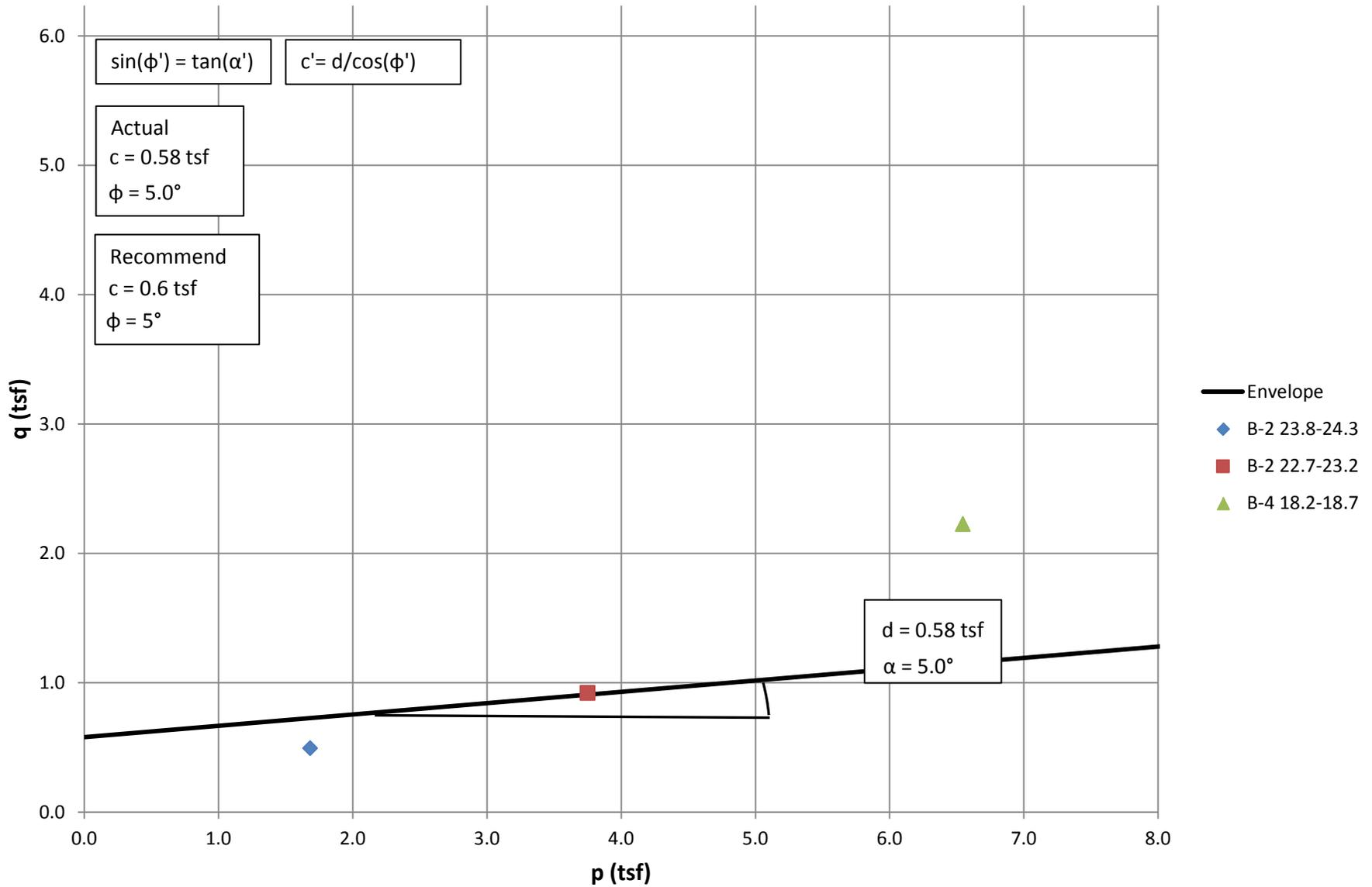
Figure 34. Empirical correlation between friction angle of sands and normalized standard penetration blow count (after Terzaghi et al., 1996)

UNDRAINED CALCULATIONS: BOILER SLAG POND DAM

Embankment Fill (Clifty Creek Boiler Slag Pond Dam) Total Stress Failure Points from CU Triaxial Tests



Lean Clay with Sand (Clifty Creek Boiler Slag Pond Dam) Total Stress Failure Points from CU Triaxial Tests



PLANT: CLIFTY CREEK

FACILITY: BOILER SLAG POND DAM

MATERIAL: EMBANKMENT FILL

$\sigma_1 - \sigma_3$ (plot) (psi)	σ_3' (lab request) (psi)	σ_1' (psi)	u (plot) (psi)	σ_1 (psi)	σ_3 (psi)
20	10	30	5	35	15
42	20	62	17	79	37
47	30	77	27	104	57

MATERIAL: LEAN CLAY w/ SAND

$\sigma_1 - \sigma_3$ (plot) (psi)	σ_3' (lab request) (psi)	σ_1' (psi)	u (plot) (psi)	σ_1 (psi)	σ_3 (psi)
14	10	24	7	31	17
26	20	46	19	65	39
62	30	92	30	122	60

CALCULATED BY: J. SWINGLE



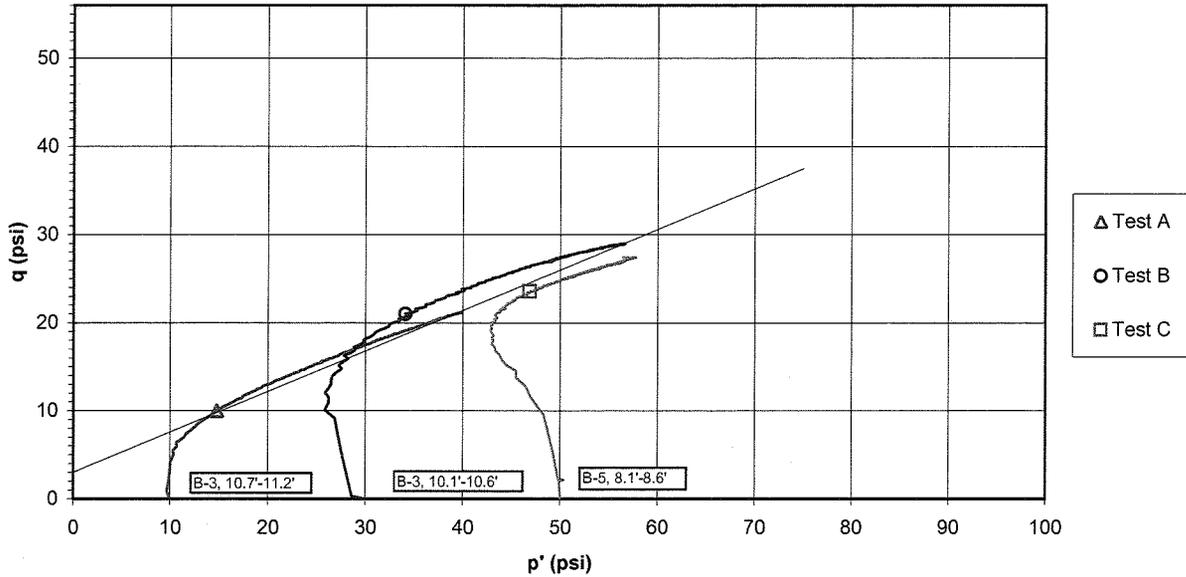
**Consolidated Undrained Triaxial Test
ASTM D4767-04**

Project AEP-Clifty Creek-West Bottom and Fly Ash Ponds subsurface exploration
 Sample ID B-3, 10.7'-11.2' & B-3, 10.1'-10.6' & B-5, 8.1'-8.6'

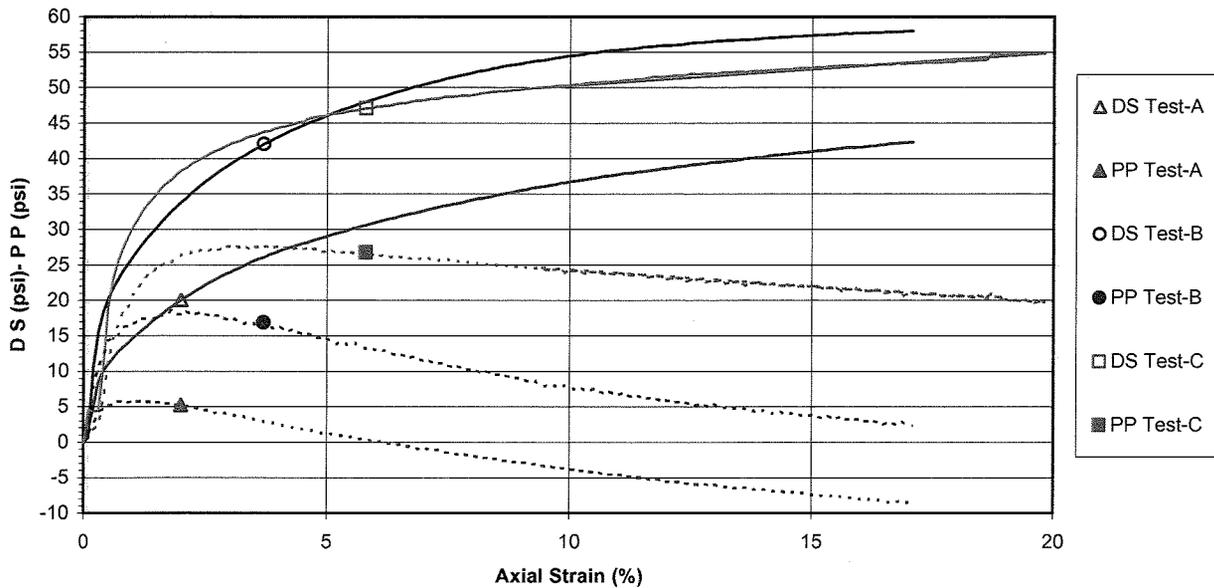
Project No. 175539022
 Test Number 1

$\phi' = 27.4 \text{ deg.}$
 $c' = 490 \text{ psf}$
 Failure Criterion: Maximum Effective Principal Stress Ratio

p' vs. q Plot



Deviator Stress and Induced Pore Pressure vs. Axial Strain





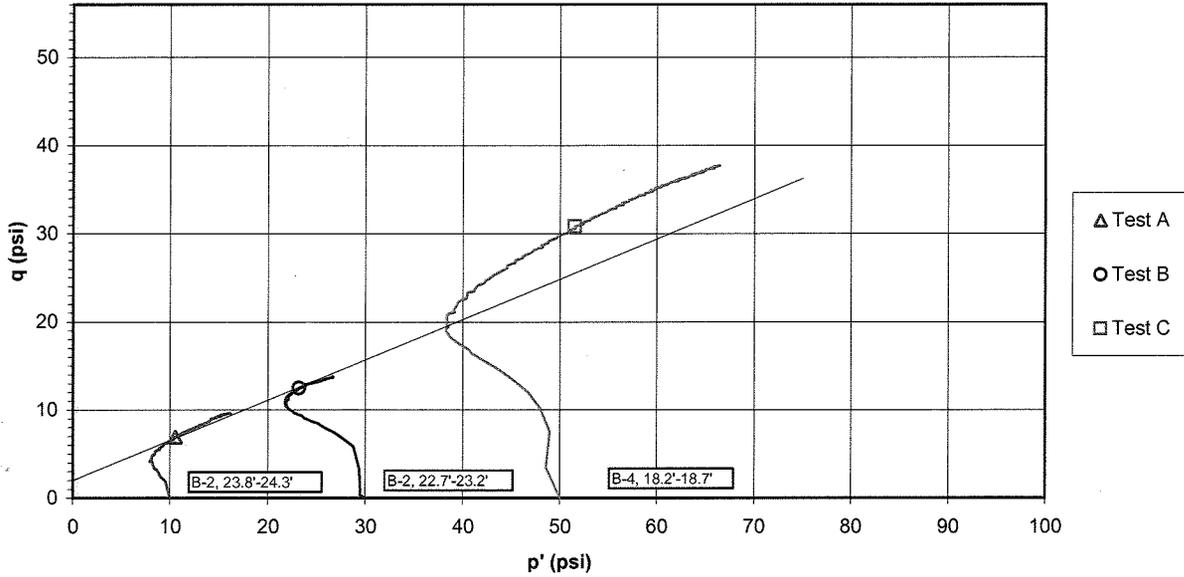
**Consolidated Undrained Triaxial Test
ASTM D4767-04**

Project AEP-Clifty Creek-West Bottom Ash and Fly Ash Ponds subsurface exploration
 Sample ID B-2, 23.8'-24.3' & B-2, 22.7'-23.2' & B-4, 18.2'-18.7'

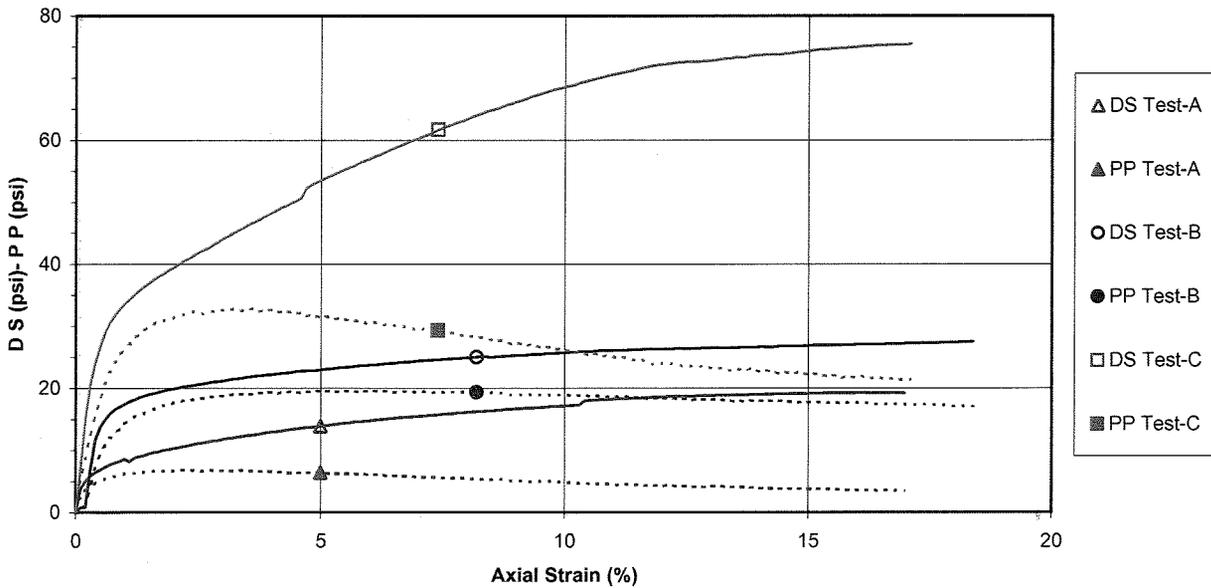
Project No. 175539022
 Test Number 2

$\phi' = 27.2 \text{ deg.}$
 $c' = 320 \text{ psf}$
 Failure Criterion: Maximum Effective Principal Stress Ratio

p' vs. q Plot

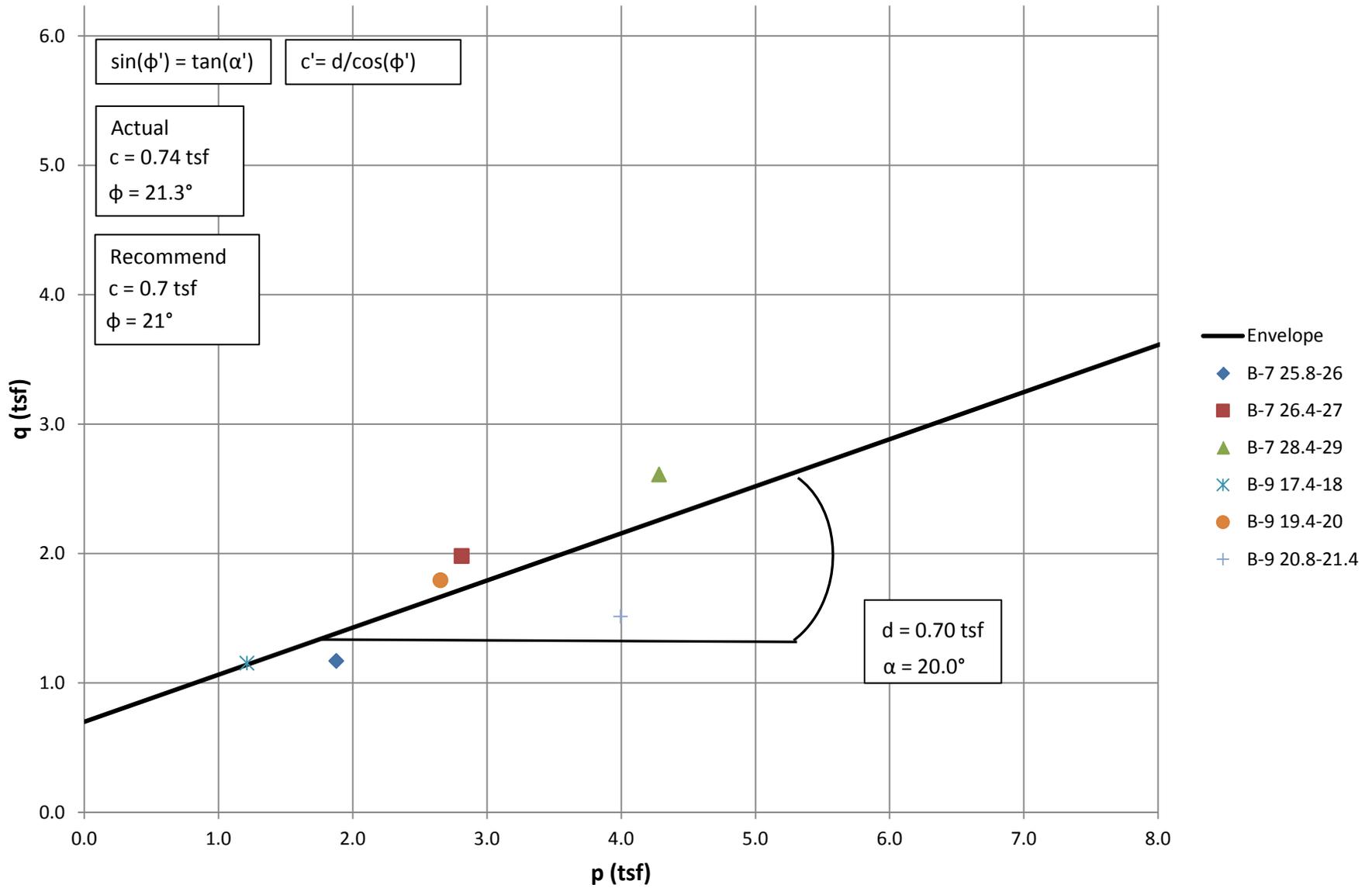


Deviator Stress and Induced Pore Pressure vs. Axial Strain

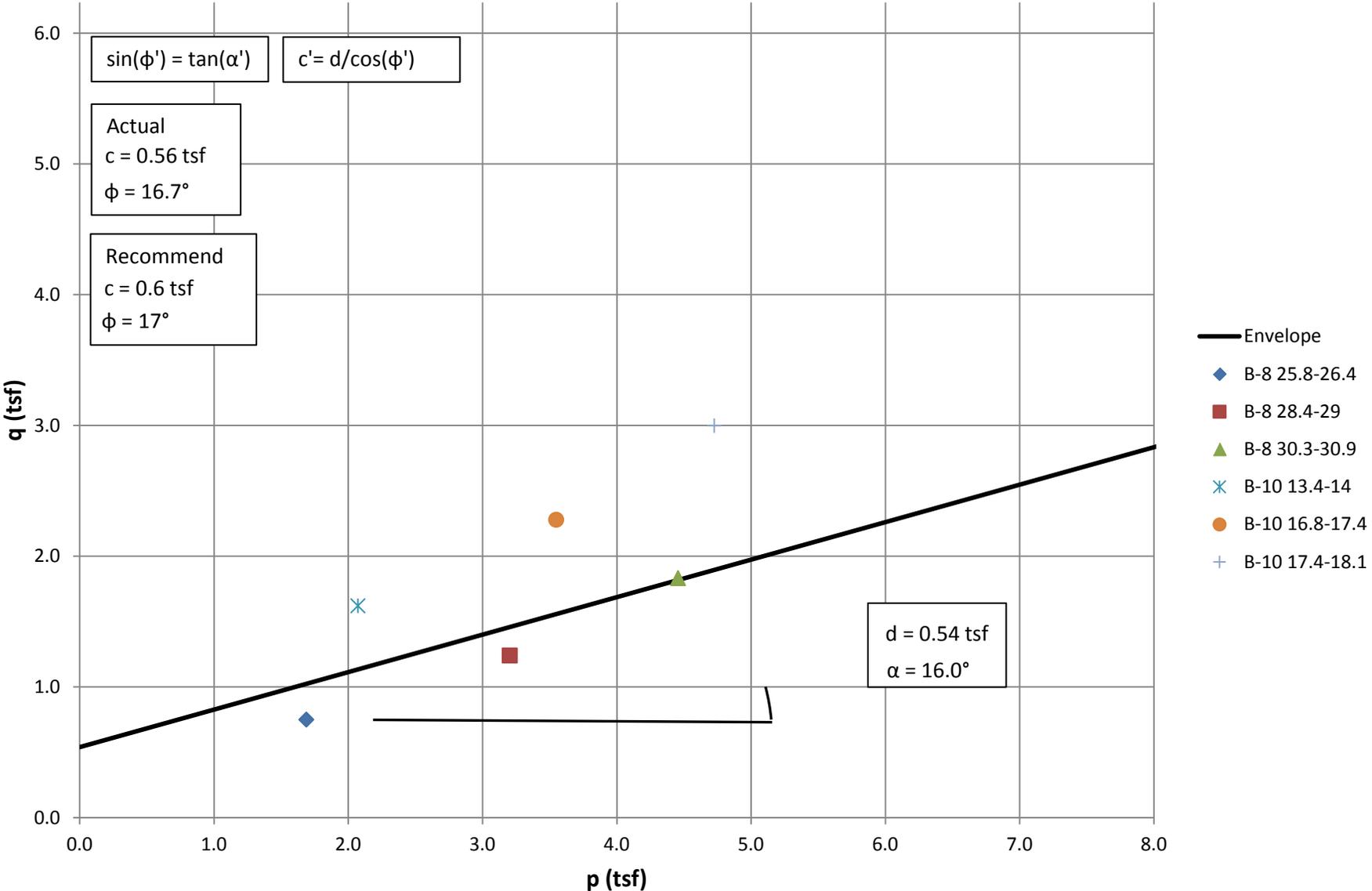


UNDRAINED CALCULATIONS: LANDFILL
RUNOFF COLLECTION POND

Embankment Fill (Clifty Creek Fly Ash Pond Dam) Total Stress Failure Points from CU Triaxial Tests



Lean Clay with Sand (Clifty Creek Fly Ash Pond Dam) Total Stress Failure Points from CU Triaxial Tests



PLANT: CLIFTY CREEK

FACILITY: LANDFILL RUNOFF COLLECTION POND

MATERIAL: EMBANKMENT

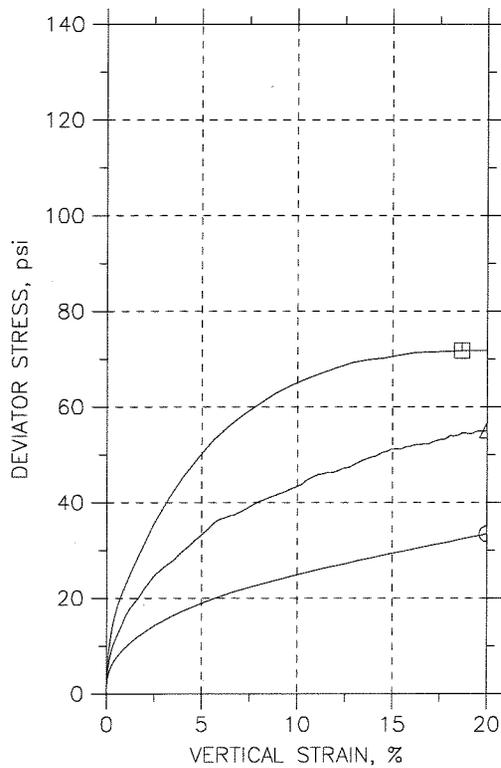
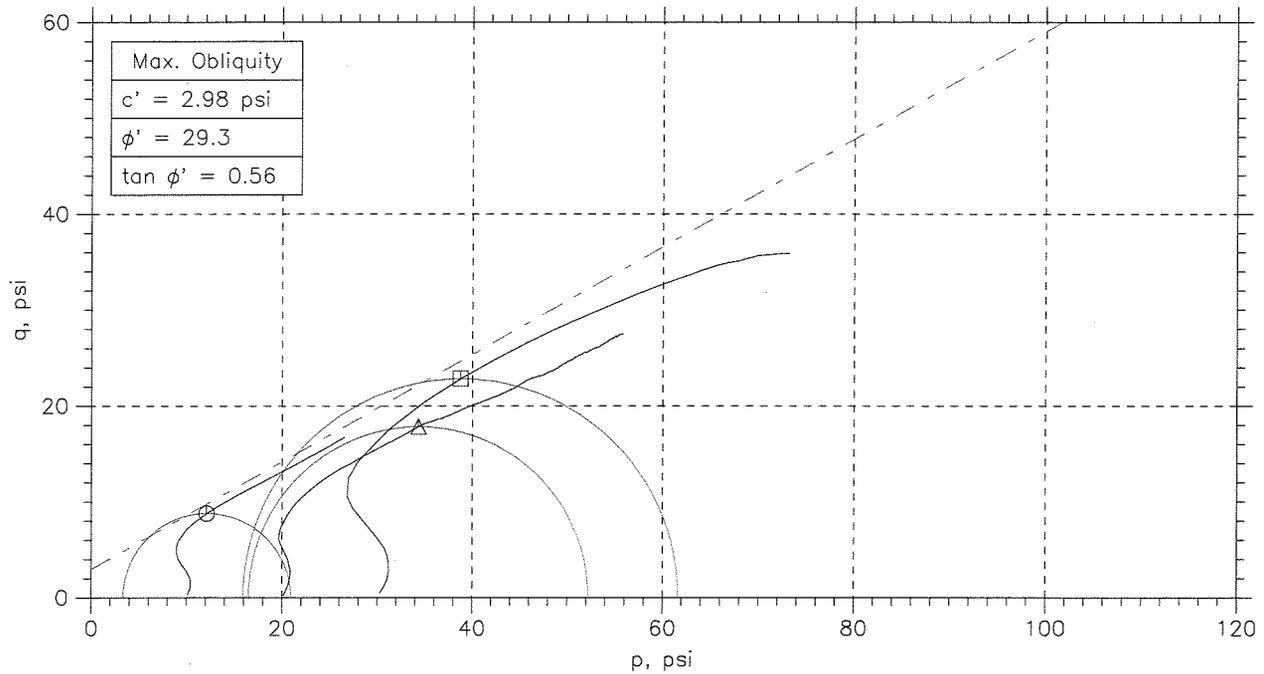
	$\sigma_1' - \sigma_3'$ (plot) (psi)	σ_3' (table) (psi)	σ_1' (psi)	u (plot) (psi)	σ_1 (psi)	σ_3 (psi)
B-7	32.50	9.83	42.33	0.00	42.33	9.83
B-7	55.00	19.88	74.88	-8.33	66.55	11.55
B-7	72.50	29.80	102.30	-6.57	95.73	23.23
B-9	32.00	10.00	42.00	-9.15	32.85	0.85
B-9	49.81	19.96	69.77	-8.00	61.77	11.96
B-9	42.00	29.88	71.88	4.62	76.50	34.50

MATERIAL: LEAN CLAY WITH SAND

	$\sigma_1' - \sigma_3'$ (plot) (psi)	σ_3' (table) (psi)	σ_1' (psi)	u (plot) (psi)	σ_1 (psi)	σ_3 (psi)
B-8	20.84	9.97	30.81	3.05	33.86	13.02
B-8	34.42	19.98	54.42	7.30	61.72	27.28
B-8	50.88	29.96	80.84	6.50	87.34	36.46
B-10	45.00	10.00	55.00	-3.72	51.28	6.28
B-10	63.26	19.99	83.25	-2.33	80.92	17.66
B-10	83.26	30.00	113.26	-6.00	107.26	24.00

CALCULATED BY: J. SWINDLER

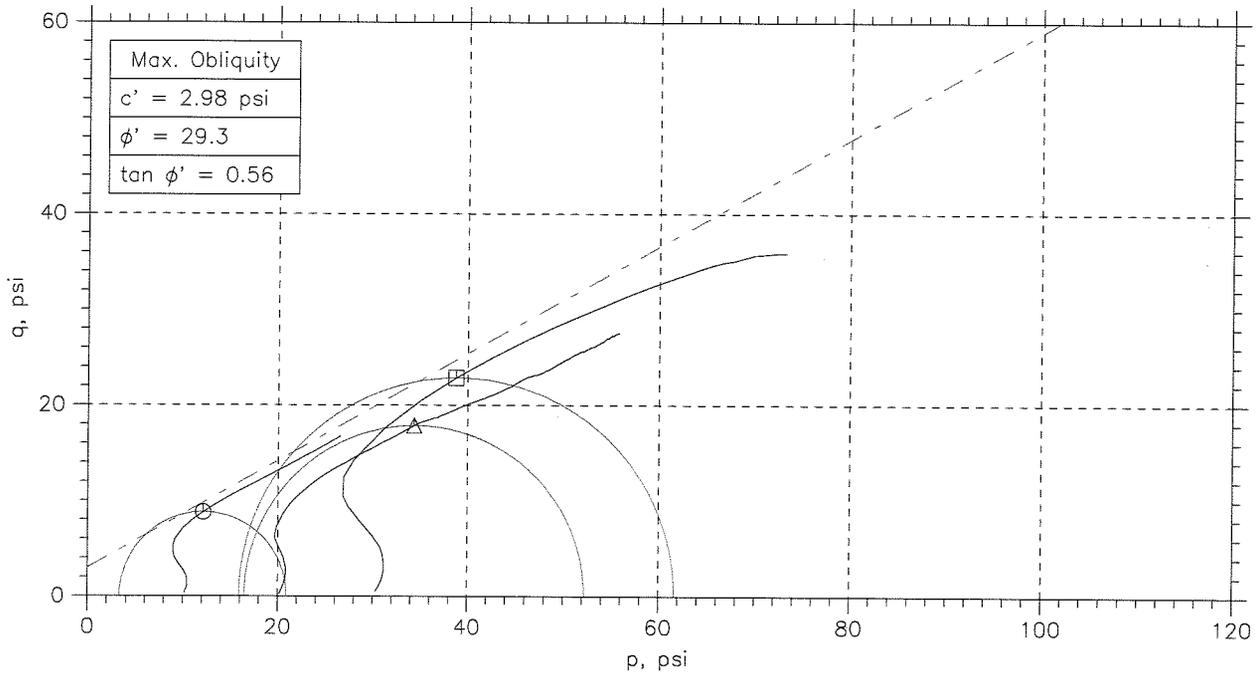
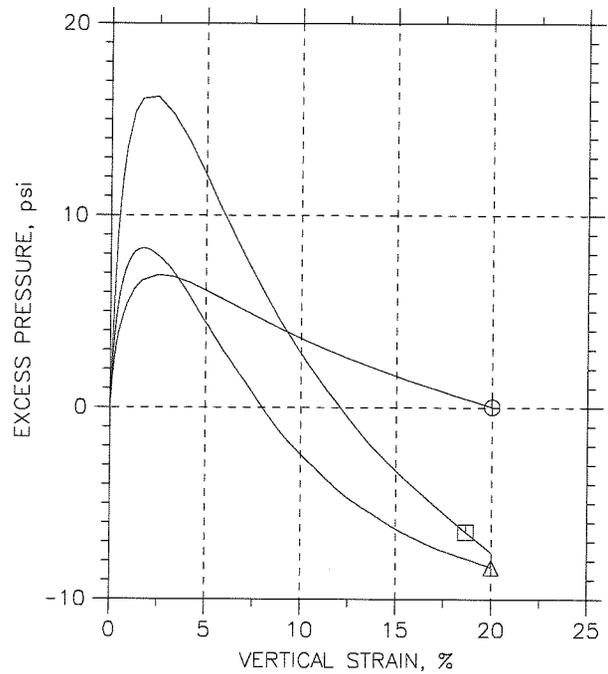
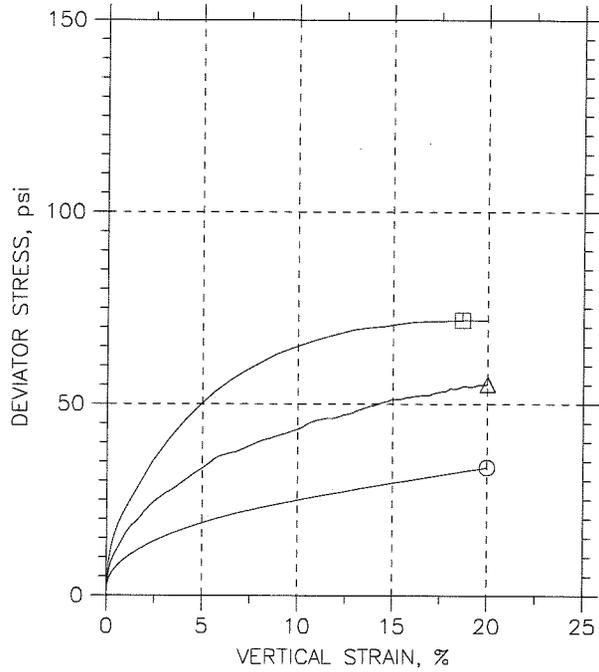
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



Symbol	○	△	□	
Sample No.	---	---	---	
Test No.	1.1	1.2	1.3	
Depth	25.8-26.0	26.4-27.0	28.4-29.0	
Initial	Diameter, in	2.835	2.834	2.832
	Height, in	6.314	5.928	5.929
	Water Content, %	20.2	21.0	19.0
	Dry Density, pcf	109.	107.5	111.3
	Saturation, %	99.8	99.6	99.7
	Void Ratio	0.546	0.568	0.515
Before Shear	Water Content, %	21.0	21.6	19.1
	Dry Density, pcf	107.7	106.5	111.2
	Saturation*, %	100.0	100.0	100.0
	Void Ratio	0.566	0.583	0.515
Back Press., psi	137.2	125.1	116.2	
Ver. Eff. Cons. Stress, psi	9.834	19.88	29.8	
Shear Strength, psi	16.74	27.57	35.9	
Strain at Failure, %	20	20	18.7	
Strain Rate, %/min	0.08	0.08	0.08	
B-Value	0.96	0.95	0.95	
Estimated Specific Gravity	2.7	2.7	2.7	
Liquid Limit	---	---	---	
Plastic Limit	---	---	---	

GeoTesting express <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek				
	Location: Jefferson, IN				
	Project No.: GTX-1516				
	Boring No.: B-7				
	Sample Type: UD				
	Description: Light Brown				
Remarks: System 1062					

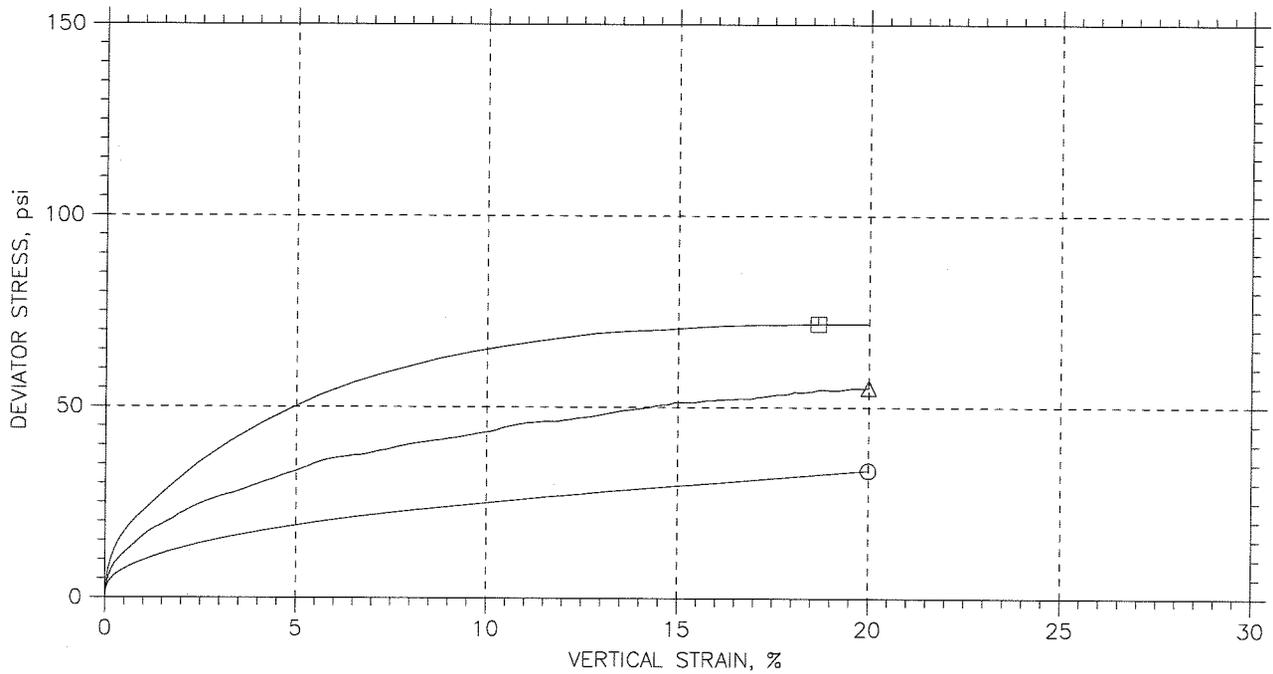
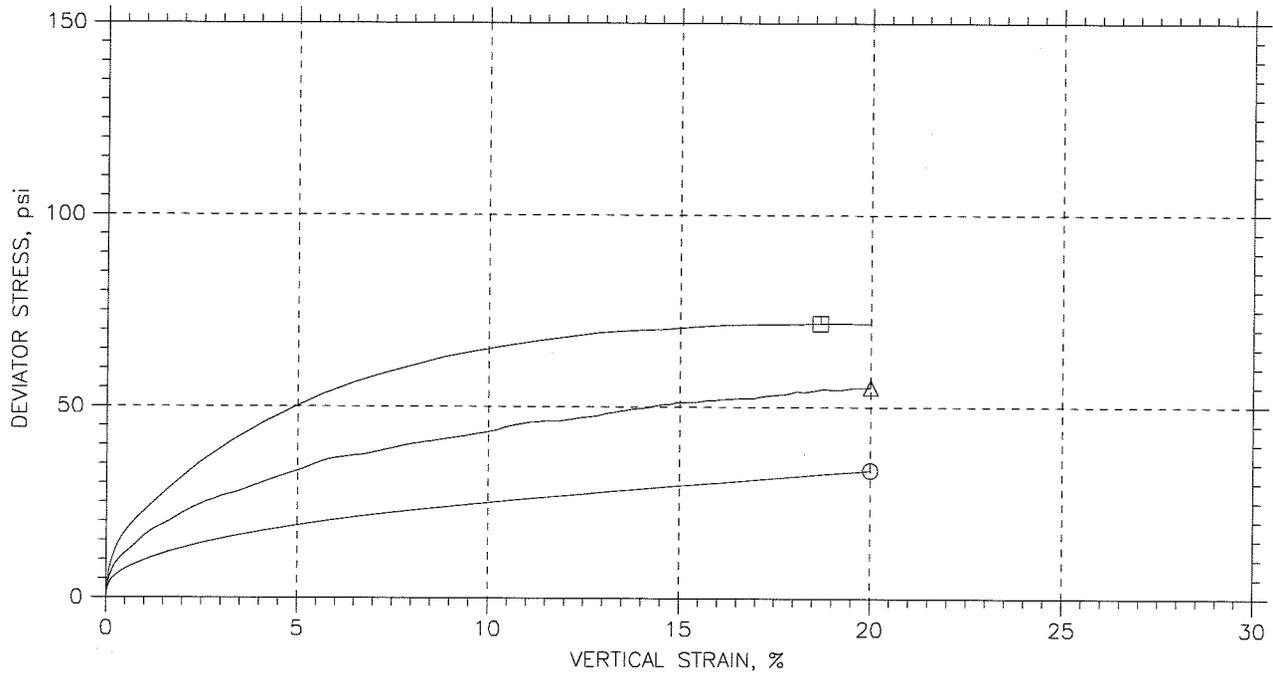
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○ ---	1.1	25.8-26.0	jm	12/10/09	mm		1516-1.1.dat
△ ---	1.2	26.4-27.0	jm	12/10/09	mm		1516-1.2.dat
□ ---	1.3	28.4-29.0	jm	12/9/09	mm		1516-1.3.dat

GeoTesting express <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek		Location: Jefferson, IN		Project No.: GTX-1516	
	Boring No.: B-7		Sample Type: UD			
	Description: Light Brown					
	Remarks: System 1062					

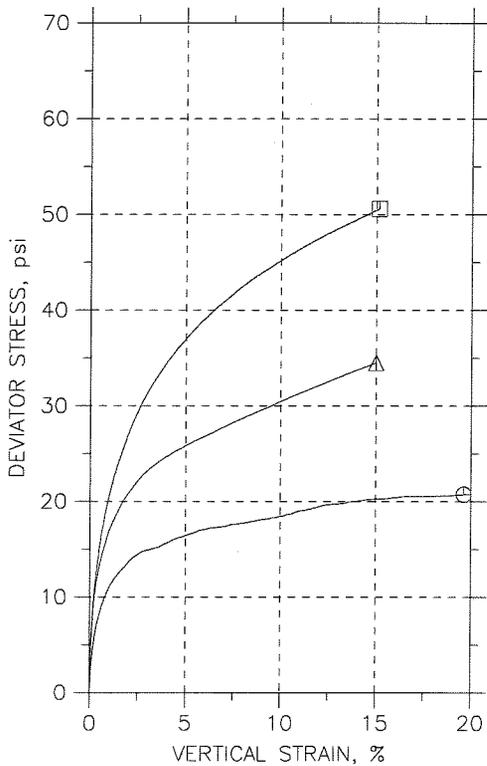
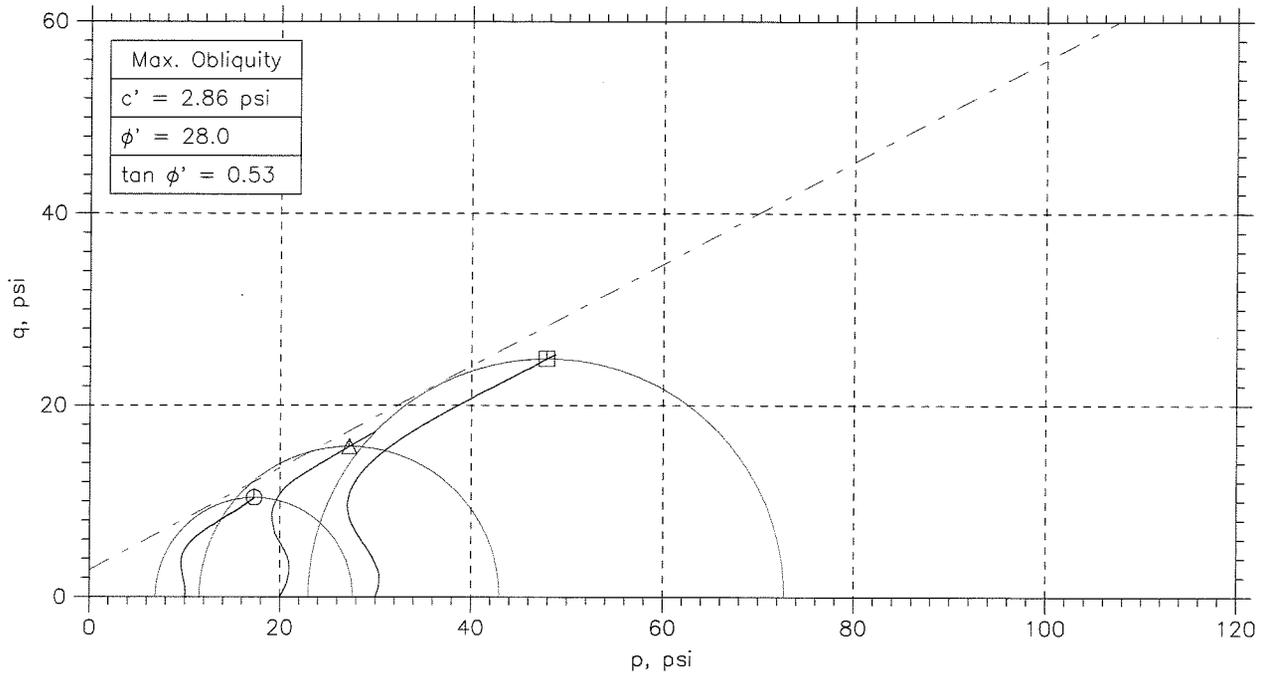
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



Symbol	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
⊙	---	1.1	25.8-26.0	jm	12/10/09	mm		1516-1.1.dat
△	---	1.2	26.4-27.0	jm	12/10/09	mm		1516-1.2.dat
□	---	1.3	28.4-29.0	jm	12/9/09	mm		1516-1.3.dat

GeoTesting express <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek		Location: Jefferson, IN		Project No.: GTX-1516	
	Boring No.: B-7		Sample Type: UD			
	Description: Light Brown					
	Remarks: System 1062					

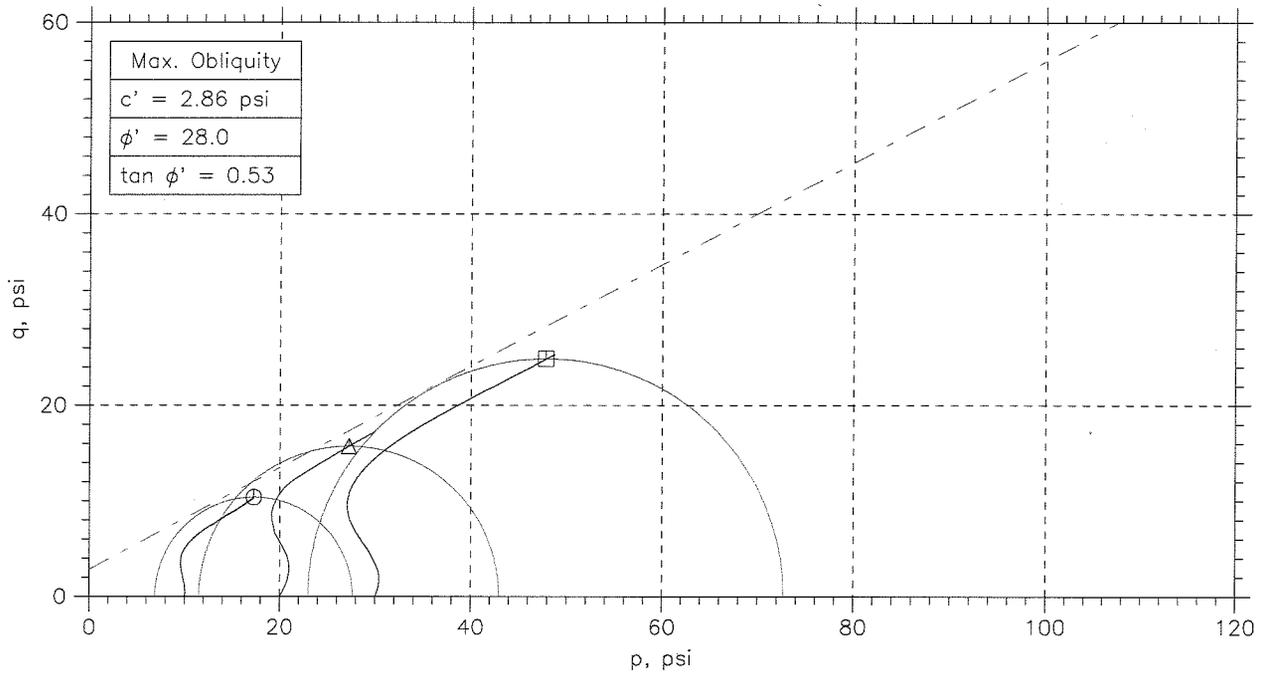
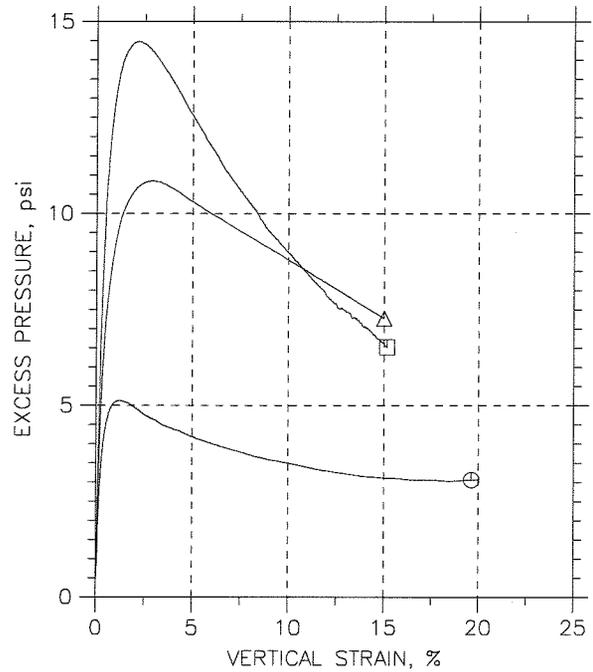
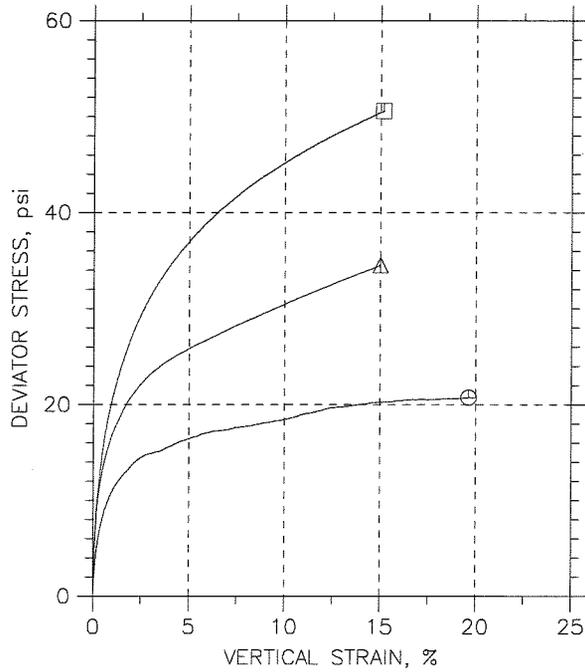
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



Symbol	⊙	△	□	
Sample No.	---	---	---	
Test No.	2.1	2.2	2.3	
Depth	25.8-26.4	28.4-29.0	30.3-30.9	
Initial	Diameter, in	2.82	2.824	2.838
	Height, in	5.82	6.027	6.001
	Water Content, %	21.0	20.7	20.9
	Dry Density, pcf	107.2	107.6	107.6
	Saturation, %	99.2	98.7	99.6
	Void Ratio	0.572	0.567	0.567
Before Shear	Water Content, %	20.5	19.8	19.0
	Dry Density, pcf	108.5	109.8	111.4
	Saturation*, %	100.0	100.0	100.0
	Void Ratio	0.554	0.535	0.513
Back Press., psi	59.25	124.8	56.31	
Ver. Eff. Cons. Stress, psi	9.968	19.98	29.96	
Shear Strength, psi	10.37	17.25	25.3	
Strain at Failure, %	19.6	15	15.2	
Strain Rate, %/min	0.016	0.016	0.016	
B-Value	0.95	0.96	0.95	
Estimated Specific Gravity	2.7	2.7	2.7	
Liquid Limit	---	---	---	
Plastic Limit	---	---	---	

GeoTesting express <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek				
	Location: Jefferson, IN.				
	Project No.: GTX-1516				
	Boring No.: B-8				
	Sample Type: UD				
	Description: Greenish brown lean clay with sand				
Remarks: 2054					

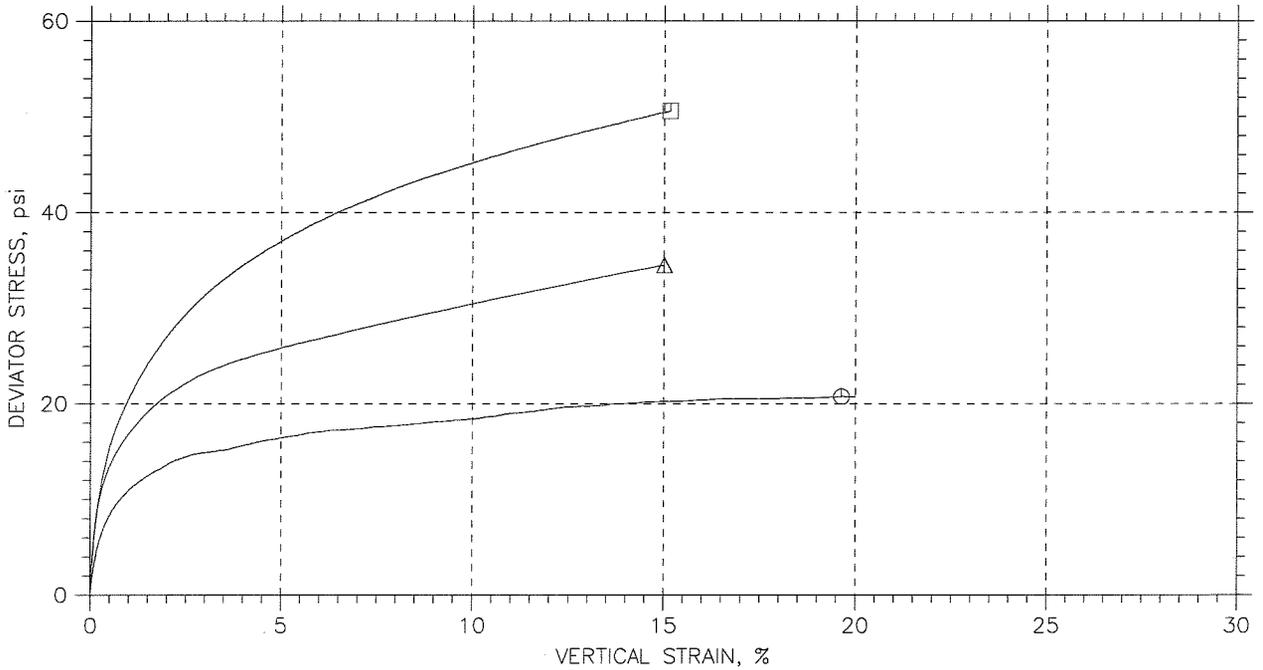
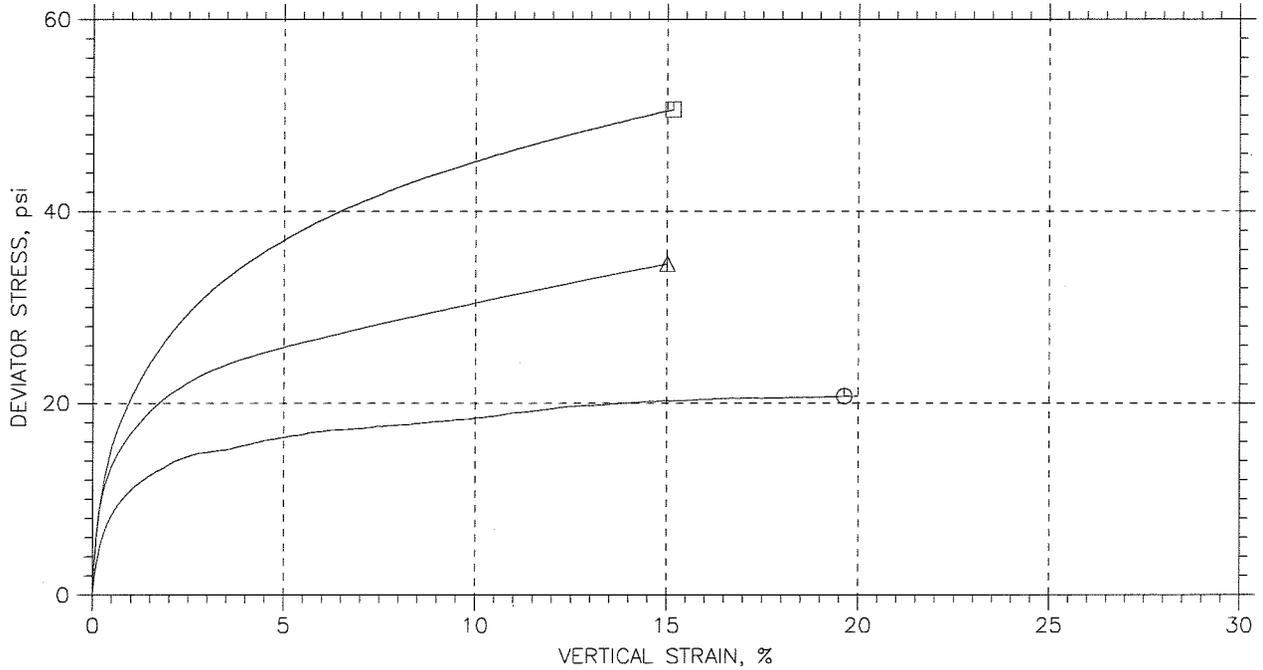
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	2.1	25.8-26.4	jm	12/11/09	mm		1516-2.1.dat
△	---	2.2	28.4-29.0	jm	12/11/09	mm		1516-2.2A.dat
□	---	2.3	30.3-30.9'	jm	12/09/09	mm		1516-2.3.dat

GeoTesting express <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek		Location: Jefferson, IN.		Project No.: GTX-1516	
	Boring No.: B-8		Sample Type: UD			
	Description: Greenish brown lean clay with sand					
	Remarks: 2054					

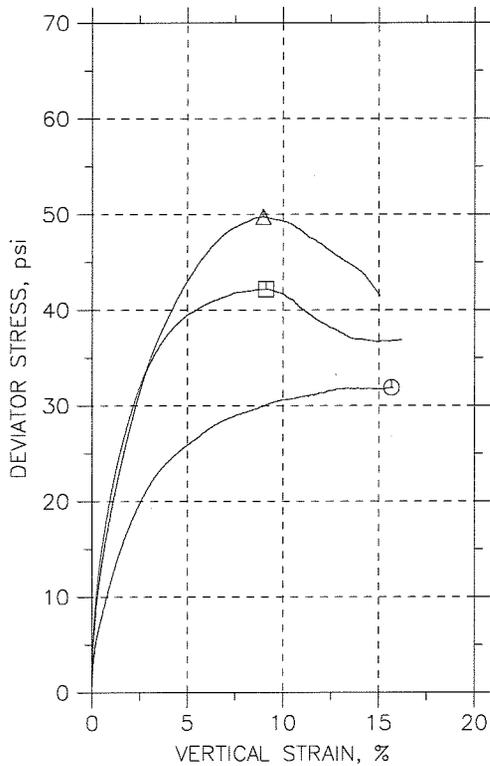
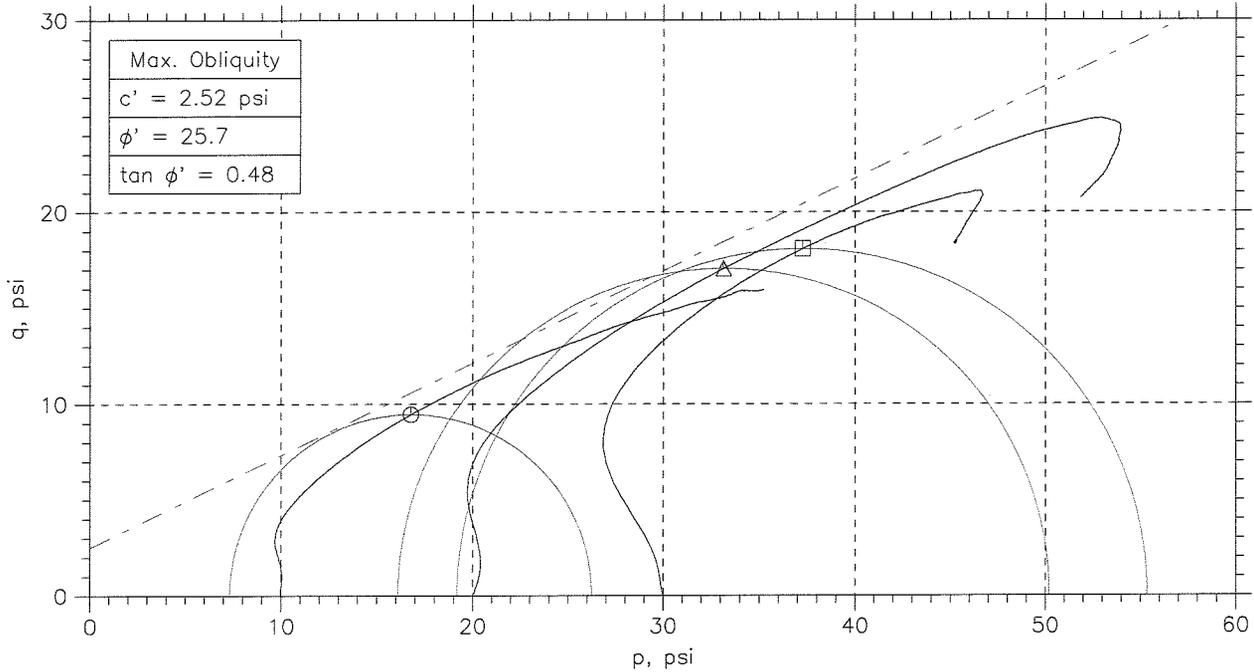
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



Symbol	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	2.1	25.8-26.4	jm	12/11/09	mm		1516-2.1.dat
△	---	2.2	28.4-29.0	jm	12/11/09	mm		1516-2.2A.dat
□	---	2.3	30.3-30.9'	jm	12/09/09	mm		1516-2.3.dat

GeoTesting express <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek		Location: Jefferson, IN.	
	Boring No.: B-8		Project No.: GTX-1516	
	Description: Greenish brown lean clay with sand		Sample Type: UD	
	Remarks: 2054			

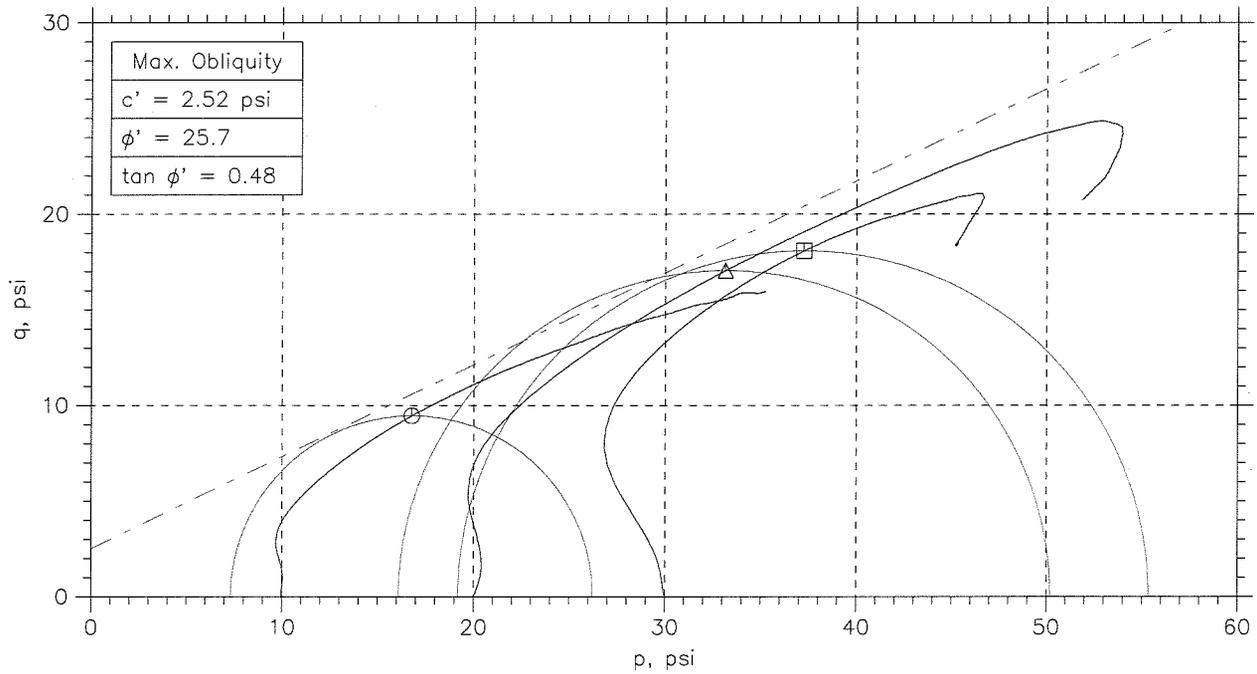
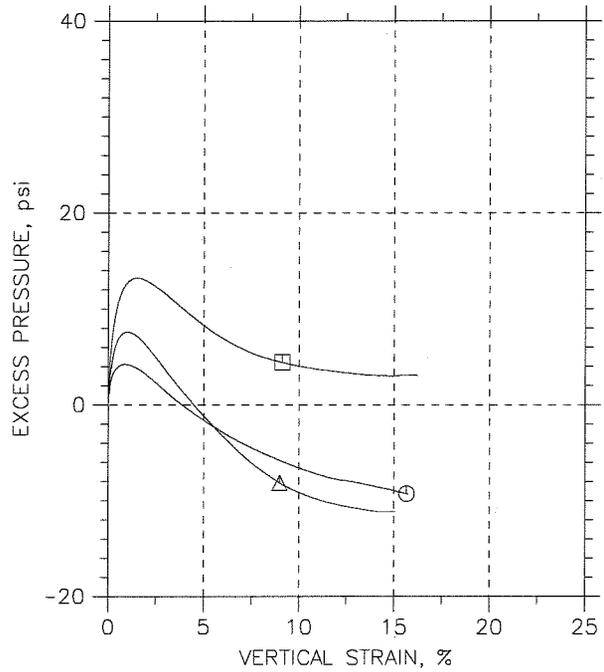
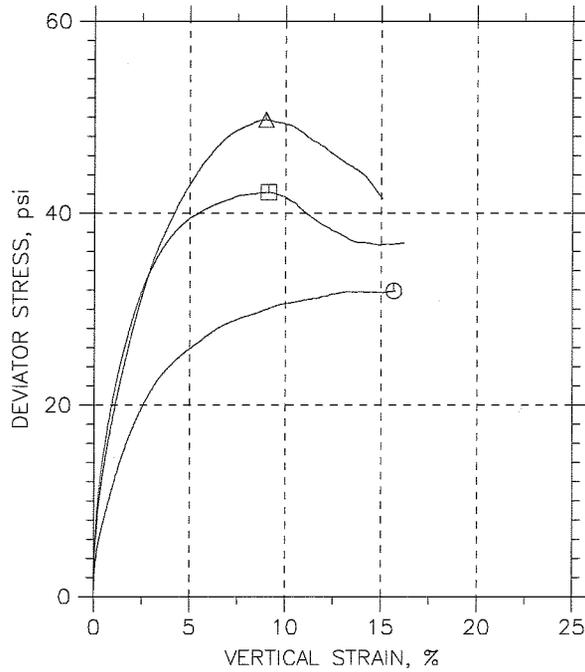
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



Symbol	○	△	□	
Sample No.	---	---	---	
Test No.	3.1	3.2	3.3	
Depth	17.4-18.0	19.4-20.0	20.8--21.4	
Initial	Diameter, in	2.835	2.835	2.837
	Height, in	6.319	6.281	6.177
	Water Content, %	19.4	18.4	20.8
	Dry Density, pcf	109.7	111.4	107.3
	Saturation, %	97.8	96.9	98.6
Before Shear	Void Ratio	0.536	0.514	0.571
	Water Content, %	19.2	18.9	22.7
	Dry Density, pcf	111.	111.7	104.5
	Saturation*, %	100.0	100.0	100.0
Before Shear	Void Ratio	0.518	0.509	0.613
	Back Press., psi	136.8	122	116.2
Ver. Eff. Cons. Stress, psi	9.997	19.96	29.88	
Shear Strength, psi	15.94	24.86	21.08	
Strain at Failure, %	15.7	8.98	9.12	
Strain Rate, %/min	0.016	0.016	0.016	
B-Value	0.95	0.96	0.95	
Estimated Specific Gravity	2.7	2.7	2.7	
Liquid Limit	---	---	---	
Plastic Limit	---	---	---	

GeoTesting express <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek				
	Location: Jefferson, IN				
	Project No.: GTX-1516				
	Boring No.: B-9				
	Sample Type: UD				
	Description: Brown lean clay with sand				
Remarks: System 1057					

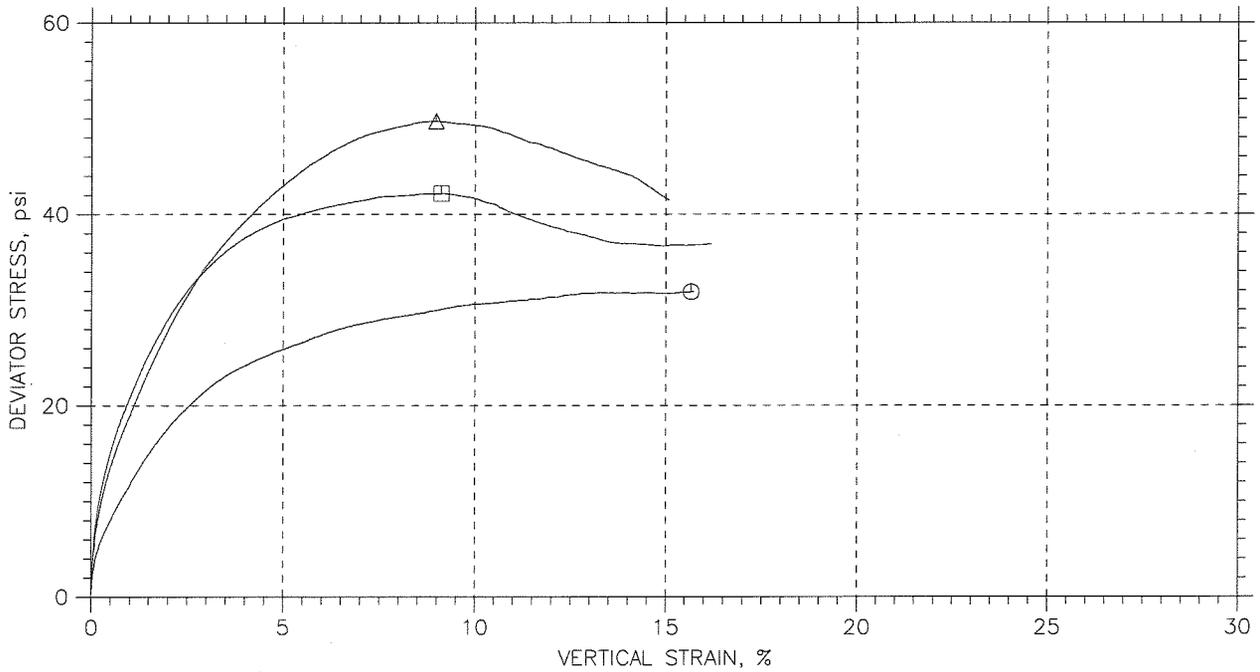
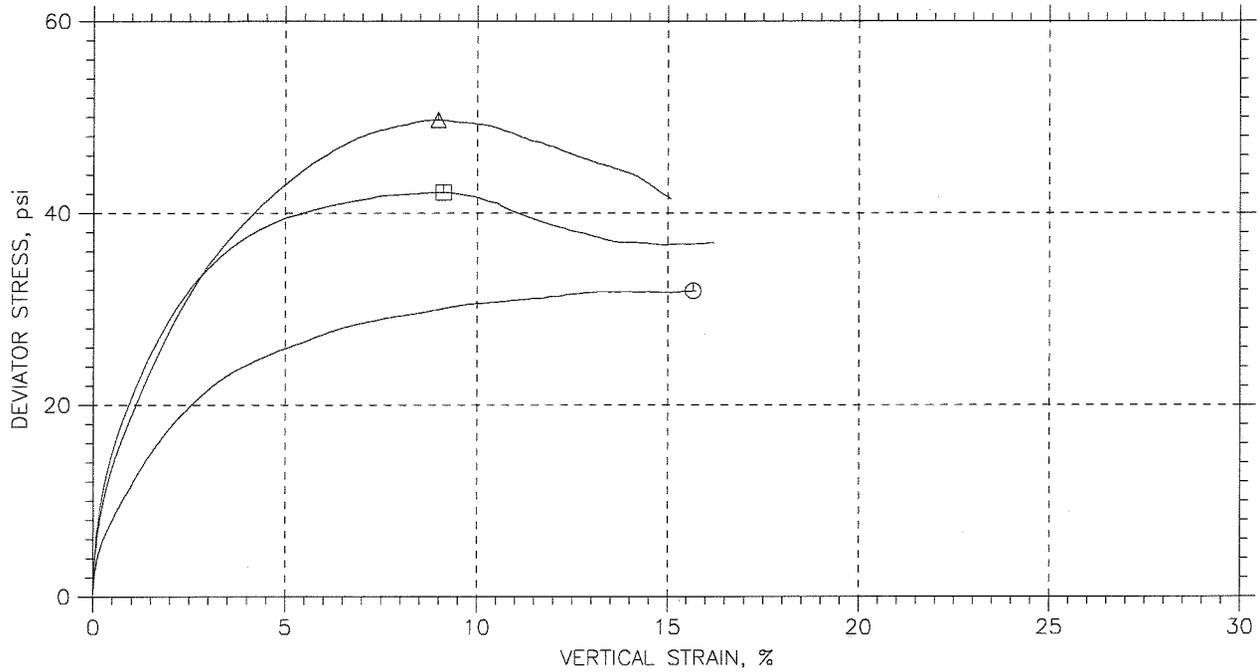
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
⊙	---	3.1	17.4-18.0	jm	12/15/09	mm		1516-3.1.dat
△	---	3.2	19.4-20.0	jm	12/16/09	mm		1516-3.2Adat.dat
□	---	3.3	20.8--21.4	jm	12/10/09	mm		1516-3.3.dat

GeoTesting express <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek		Location: Jefferson, IN		Project No.: GTX-1516	
	Boring No.: B-9		Sample Type: UD			
	Description: Brown lean clay with sand					
	Remarks: System 1057					

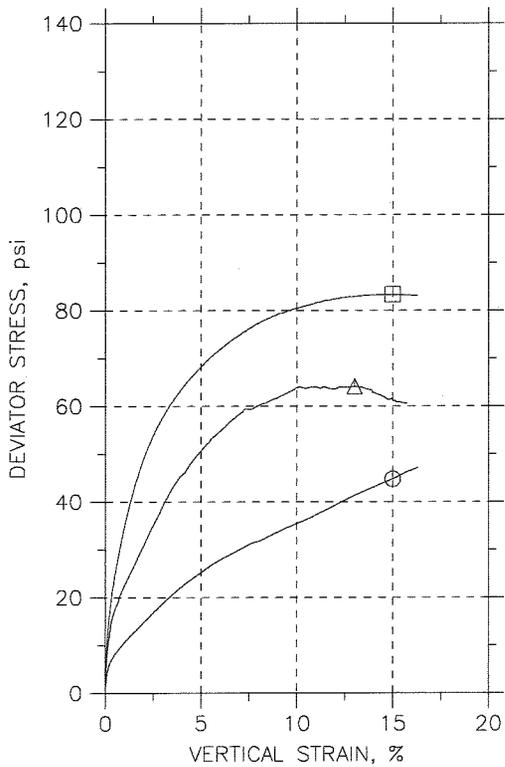
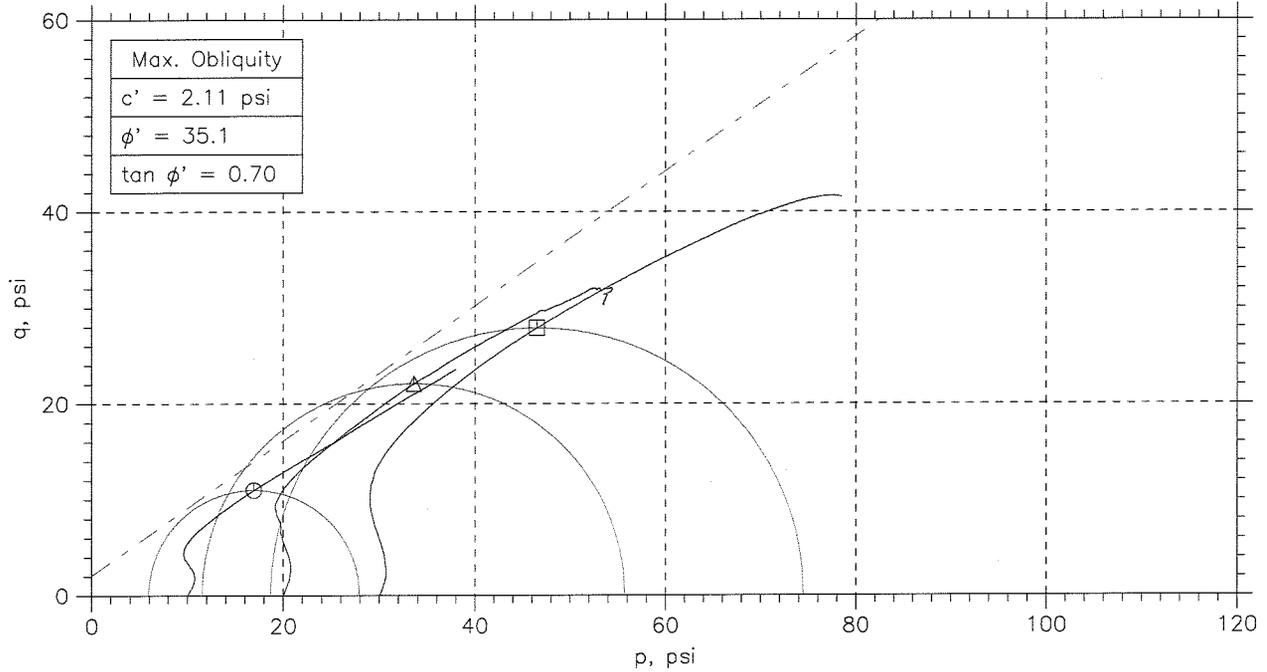
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
⊗	---	3.1	17.4-18.0	jm	12/15/09	mm		1516-3.1.dat
△	---	3.2	19.4-20.0	jm	12/16/09	mm		1516-3.2A.dat.dat
□	---	3.3	20.8--21.4	jm	12/10/09	mm		1516-3.3.dat

GeoTesting express <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek		Location: Jefferson, IN		Project No.: GTX-1516	
	Boring No.: B-9		Sample Type: UD			
	Description: Brown lean clay with sand					
	Remarks: System 1057					

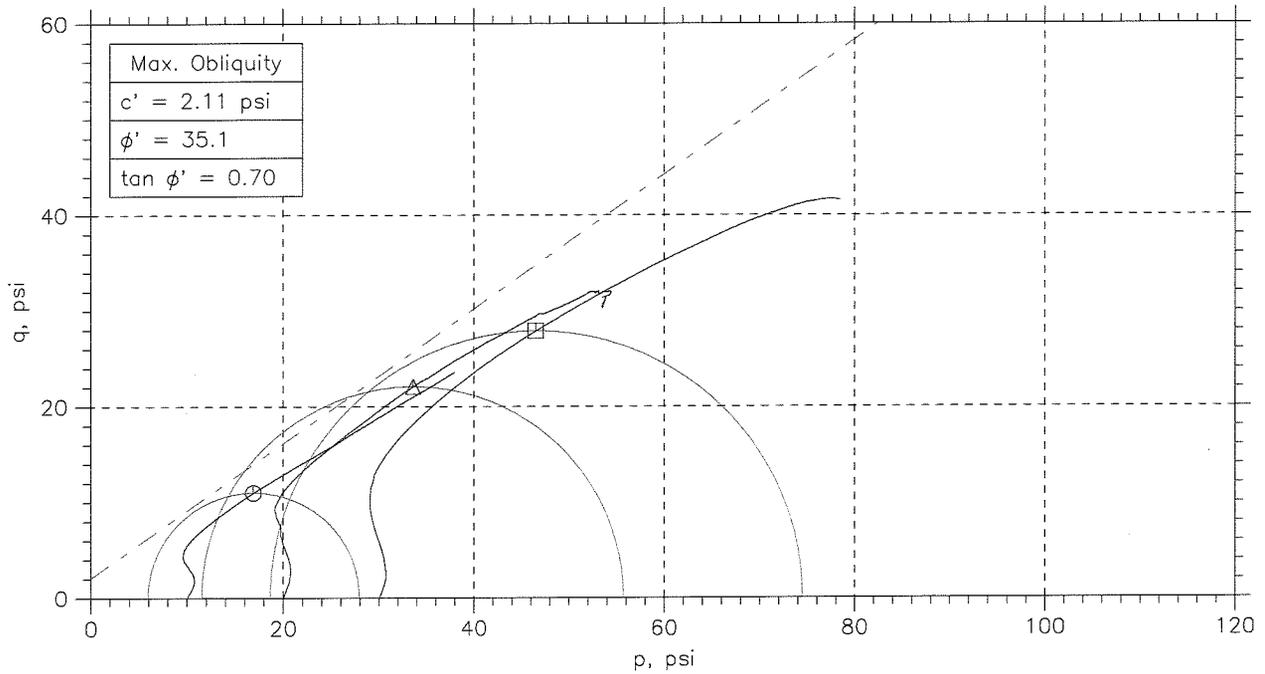
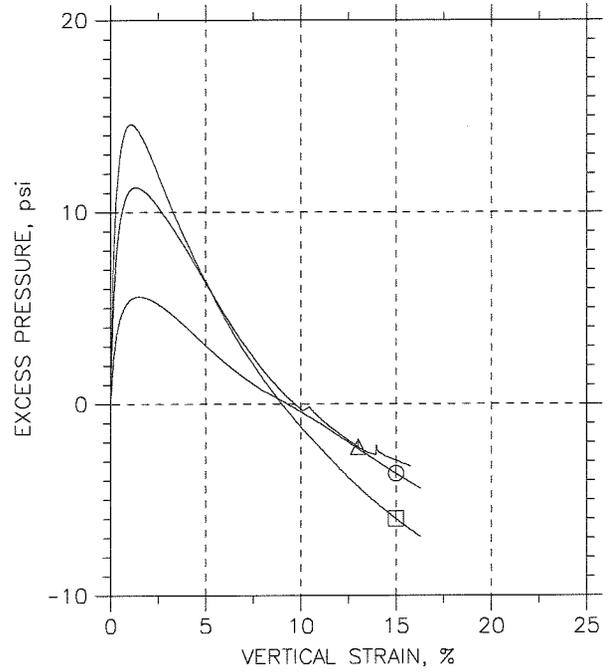
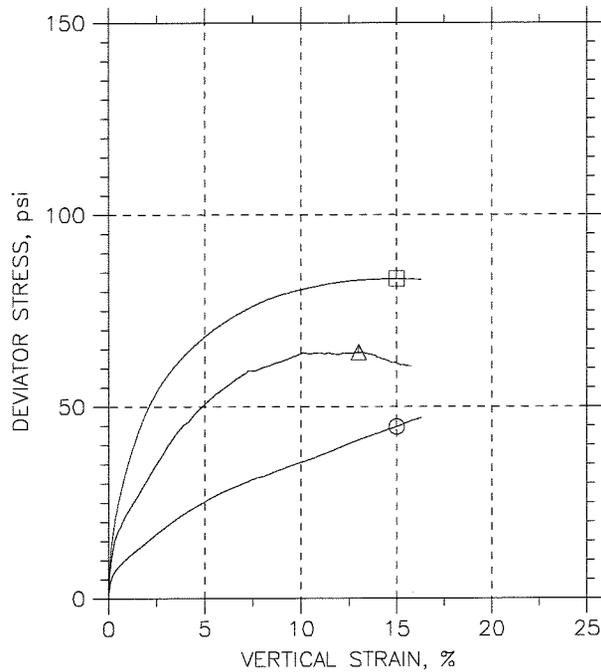
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



Symbol	○	△	□	
Sample No.	---	---	---	
Test No.	CU-4.1	CU-4.2	CU-4.3	
Depth	13.4-14.0'	16.8-17.4'	17.4-18.1'	
Initial	Diameter, in	2.83	2.71	2.72
	Height, in	5.78	5.52	5.51
	Water Content, %	14.2	27.4	26.6
	Dry Density, pcf	102.9	93.8	93.72
	Saturation, %	59.9	93.0	89.9
	Void Ratio	0.638	0.797	0.798
Before Shear	Water Content, %	23.2	18.5	19.2
	Dry Density, pcf	103.7	112.4	111.
	Saturation*, %	100.0	100.0	100.0
	Void Ratio	0.625	0.5	0.519
	Back Press., psi	27.99	73	84.99
Ver. Eff. Cons. Stress, psi	10	19.99	30	
Shear Strength, psi	22.37	32.06	41.66	
Strain at Failure, %	15	13	15	
Strain Rate, %/min	0.032	0.032	0.032	
B-Value	0.95	0.95	0.96	
Estimated Specific Gravity	2.7	2.7	2.7	
Liquid Limit	---	---	---	
Plastic Limit	---	---	---	

GeoTesting express <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek				
	Location: ----				
	Project No.: GTX-1516				
	Boring No.: B-10				
	Sample Type: UD				
	Description:				
Remarks: 2054					

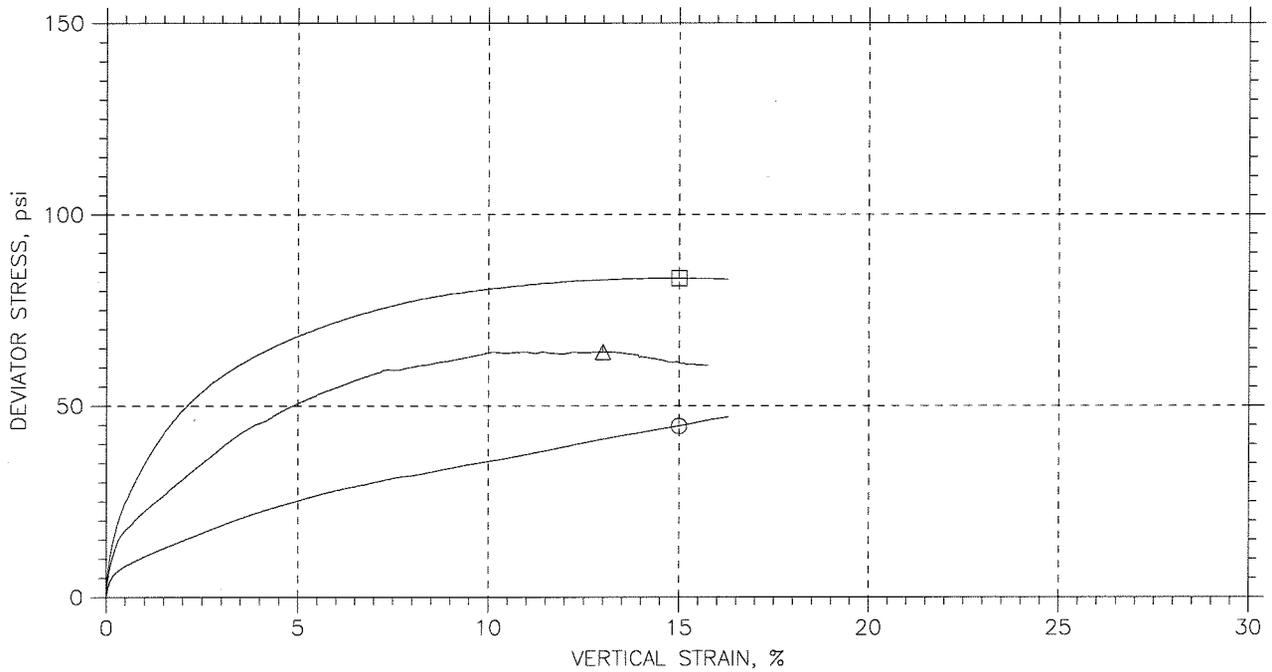
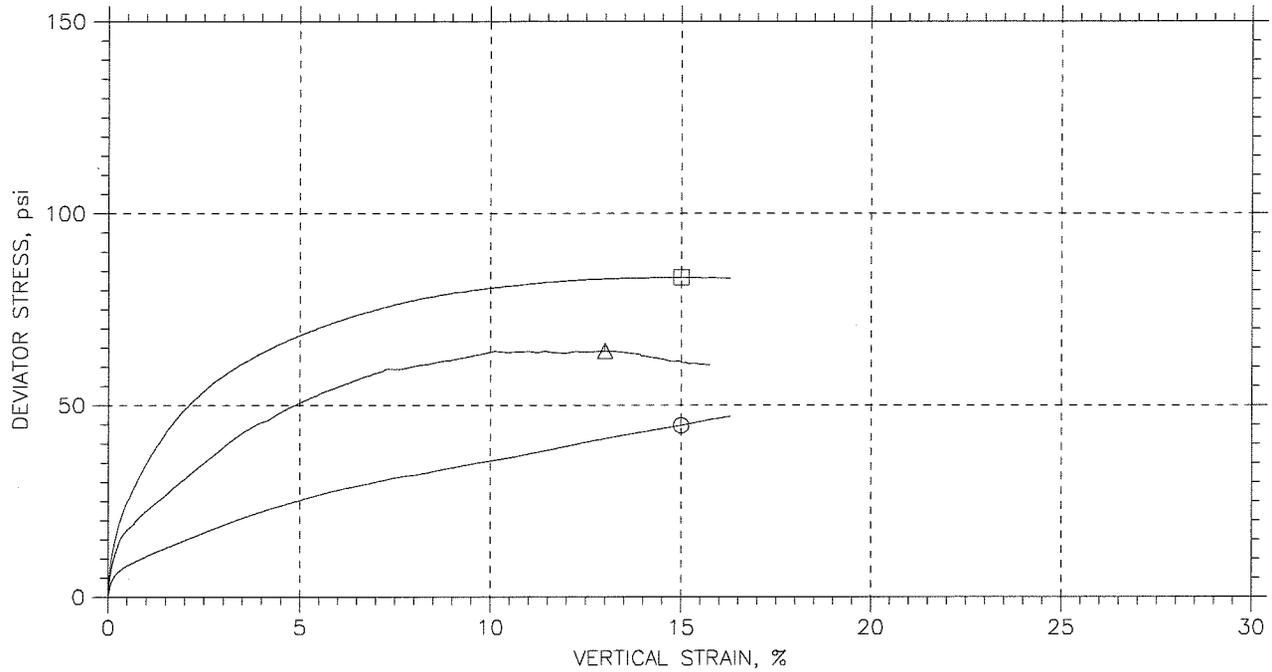
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	---	CU-4.1	13.4-14.0'	JM	12/12/09	MM		1516-4.1.dat
△	----	CU-4.2	16.8-17.4'	JM	12/13/09	MM		1516-4.2.dat
□	----	CU-4.3	17.4-18.'	JM	12/12/09	MM		1516-4.3.dat

GeoTesting express <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek		Location: ----		Project No.: GTX-1516	
	Boring No.: B-10		Sample Type: UD			
	Description:					
	Remarks: 2054					

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



Symbol	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
⊙	---	CU-4.1	13.4-14.0'	JM	12/12/09	MM		1516-4.1.dat
△	----	CU-4.2	16.8-17.4'	JM	12/13/09	MM		1516-4.2.dat
□	----	CU-4.3	17.4-18.'	JM	12/12/09	MM		1516-4.3.dat

GeoTesting express <small>a subsidiary of Geocomp Corporation</small>	Project: Clifty Creek		Location: ----		Project No.: GTX-1516	
	Boring No.: B-10		Sample Type: UD			
	Description:					
	Remarks: 2054					