GEOTECHNICAL EXPLORATION

ADVANCED TREATMENT, GAC

NKWD FT. THOMAS TREATMENT PLANT

FT. THOMAS, KENTUCKY

Prepared for: **CH2M Hill**

Thelen Project No.: **080978E**

THELEN ASSOCIATES, INC.
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July 22, 2009

CH2M Hill
300 E. Business Way, Suite 400
Cincinnati, Ohio 45241

Attn: Mr. Nicholas Winnike, P.E.

Re: Geotechnical Exploration
Advanced Treatment, GAC
NKWD Ft. Thomas Treatment Plant
Ft. Thomas, Kentucky

Ladies and Gentlemen:

We are pleased to submit to you the attached Report of Geotechnical Exploration for the above referenced project. The report includes a description of the proposed project site, a description of the test boring and laboratory testing programs, as well as conclusions and geotechnical recommendations. The report was prepared in accordance with CH2M Hill Purchase Order No. 931064 issued on October 28, 2008.

We have included in the Appendix to this report a reprint of "Important Information About your Geotechnical Engineering Report" published by ASFE, Professional Firms Practicing in the Geosciences, which our firm would like to introduce to you at this time.

We appreciate the opportunity to provide our geotechnical services for this project. Should you have any questions regarding our conclusions and recommendations, or if we may be of further assistance to you, please do not hesitate to contact us.

Respectfully submitted,
THELEN ASSOCIATES, INC.

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1.0 INTRODUCTION

Presented in this draft report are the results of our geotechnical exploration for the proposed Advanced Treatment Granular Activated Carbon (GAC) Building at the Northern Kentucky Water District (NKWD) Fort Thomas Treatment Plant. The main purpose of this exploration was to determine the general subsurface profile at the site and to relate the engineering properties of the soil and bedrock, that is their classification, strength and compressibility characteristics, to the proposed building foundation design and to site development. The geotechnical work included test borings, laboratory testing, engineering analysis, and preparation of this report.

2.0 PROJECT DESCRIPTION

The NKWD Fort Thomas Treatment Plant is located near the intersection of US 27 (Alexandria Pike) with Grandview Avenue in Fort Thomas, Kentucky. Our understanding of the proposed site development is based on a site visit, conversations with Mr. Nicholas Winnicke, PE of CH2M Hill, and on our review of plans and drawings posted to the CH2M Hill Sharepoint site on December 15, 2008 and updated on March 6, 2009 and April 15, 2009. The proposed facility upgrade includes a new multi-story GAC Building with Equalization (EQ) Tanks. Additionally, a pipe discharge structure, a flow splitter box, a retaining wall, and associated supply/discharge pipelines and paved areas will be constructed as part of the treatment plant improvements.

According to plan and section drawings provided by the Designer, the proposed GAC Building will be a multi-story structure and will occupy a roughly 268 foot x 82 foot area with the long dimension oriented roughly north-south. The GAC Building will be constructed on an existing terraced hillside east of the existing Laboratory Building and south of the existing Flocculator/Clarifier Basin No. 4, as indicated on the Boring Plan, Drawing 080978E-1 in the Appendix to this report. Specifically, the southwest corner of the proposed building will be approximately 37 feet east of the east corner of the existing Laboratory Building and the north side of the proposed building will be approximately 61.8 feet south of the southwest corner of the existing Flocculator/Clarifier Basin No. 4.

The existing Laboratory Building has a lowest Finished Floor Elevation (FFE) at approximately 770.6 feet above Mean Sea Level (MSL), and the FFE of the existing Flocculator/Clarifier is at approximately 765.0 feet MSL. The existing Flocculator/Clarifier is supported on drilled shafts to bedrock. The drilled shaft foundations were used to mitigate the risk of differential settlements of the valley fills underlying the Flocculator/Clarifier Basin. The first floor level of the proposed GAC Building will include the main lobby, Electrical/HVAC Rooms, Sodium Biosulfite Room, and Operations Rooms, and will have a FFE of approximately 784.0 feet above MSL. The upper basement level will underly the entire building footprint, and will house eight GAC Contactor Vessels, the UV Disinfection Room and the GAC Pumps Room at a FFE of approximately 769.0 feet MSL. Maximum exterior wall loads of the upper basement level are expected to be on the order of 30 kips per linear foot. The lower basement level will include an EQ Tank occupying a plan area approximately 76 feet x 82 feet with a FFE of approximately 755.0 feet MSL. The south wall of the EQ Tank will be located about 25 feet north of the south boundary of the building footprint. Additionally, a Pump Well will occupy an area approximately 78 feet x 82 feet on the lower basement level. The north wall of the Well will be located flush with the north boundary of the building footprint. The FFE of the Pump Well will be at approximately 745.0 feet MSL. The maximum exterior wall loads for the Pump Well are expected to be on the order of 40 kips per linear foot, with maximum interior column loads of about 500 kips. It is estimated that an excavation up to 65 feet deep will be required to

achieve the subgrade elevation for the Pump Well and up to 55 feet deep for the EQ Tank. It should be noted that subsequent to drilling operations, the dimensions and elevation of the GAC Building were revised by the Design Team.

According to the site plan provided by the Designer, the northwest corner of the GAC Building will encroach on the paved access road leading to the south reservoir. The existing pavement will be removed and the new access road will be reconstructed slightly to the north to accommodate excavation and construction of the GAC Building. Additionally, the existing paved areas between the proposed GAC Building and the existing Filter Building will be expanded to provide adequate turn around space for the anticipated truck traffic supplying the GAC building. Further, the east portion of the existing paved access road and parking lot serving the existing Laboratory Building will be removed to accommodate the excavation lay back on the west side of the proposed GAC Building. It is our understanding that a portion of this area will be reconstructed as a concrete slab to provide truck access to the GAC Building. The proposed paved areas in the vicinity of the GAC Building are shown on the Boring Plan, Drawing 080978E-1 in the Appendix to this report. Additionally, the access road will be widened from the security gate to the lower parking lot servicing the existing Laboratory Building to accommodate the increase in traffic associated with the site improvements.

A 48-inch (I.D.) ductile iron UV effluent line will exit the GAC Building on the north side and will generally route north, then west to a proposed splitter box located roughly 30 feet north of the northwest corner of the building. Two 36-inch (I.D.) ductile iron UV effluent pipes will extend westward from the splitter box to the existing Filter Building. Two 36-inch (I.D.) ductile iron GAC Influent pipes will enter the GAC Building on the west side near the northwest corner of the building. A 30-inch (I.D.) ductile iron Backwash pipe will exit the west side of the GAC Building about 70 feet south of the northwest corner, and will extend along the west side of the Filter Building. A 24-inch (I.D.) ductile iron EQ Pump Discharge pipe will exit the GAC Building on the west side roughly 180 feet south of the northwest corner of the building, and will extend northward along the west side of the building, then eastward along the north side of the building and along the south side of the south reservoir to a headwall discharge into the south

reservoir. A 48-inch (I.D.) ductile iron pipe will exit the west wall of the GAC building about 150 feet south of the northwest corner, and will re-enter the GAC Building about 20 feet south of the northwest corner. These proposed pipelines are indicated on the Boring Plan, Drawing 080978E-1 in the Appendix to this report.

Additional structures associated with the treatment plant upgrades include: 1) A new pipeline discharge headwall will be constructed on the south bank of the south reservoir where the EQ Pump Station force main terminates; 2) A proposed flow splitter box, expected to be about 20 feet x 27 feet in plan dimension, will have a subgrade elevation of approximately 766.0 feet MSL, and will be located roughly 30 feet from the northwest corner of the proposed GAC Building; 3) A new retaining wall roughly 130 feet in length, will be constructed along the slope at the northwest corner of the existing Filter Building; and 4) a new retaining wall associated with the entrance road widening between the security gate and the lower Laboratory Building parking lot. The structures are shown on the Boring Plan, Drawing 080978E-1 in the Appendix to this report. It should be noted that these structures were not included in the original scope of work for this project and test borings were not advanced at these specific locations.

3.0 SITE TOPOGRAPHY, DEVELOPMENT HISTORY AND GEOLOGIC CONDITIONS

The project site is located within Campbell County in Northern Kentucky, which is part of the Outer Bluegrass Physiographic Region. Hilly, well-dissected upland areas and relatively steep-sided stream and river valleys characterize this area. Specifically, the GAC Building site slopes upward to the east from the existing upper Laboratory Building parking lot at about elevation 782 feet MSL, to the crest of the terraced slope at about elevation 813 feet MSL, as shown on the project site plan upon which the Boring Plan, Drawing 080978E-1 in the Appendix to this report is based. To the west and south, the site slopes downward from the existing parking lot along a terraced hillside down to US Highway 27 (Alexandria Pike). The site generally drains to an unnamed creek branch across US 27, which empties into Three Mile Creek, which in turn drains into the Licking River about 1250 feet to the southwest.

The FTTP site is located in a filled drainage valley. The terraced hillside that will be the GAC location is on the south valley wall or slope, above the fill. The north valley wall or slope is obvious (topographically) opposite the GAC site, north of the Clearwell, Sodium Hypochlorite Building and North Clarifier/Flocculator No. 3. The original valley bottom extended from U.S. 27 eastward beneath the Filter Building, and then branched into two valleys northeastward and southeastward beneath the existing north and south reservoirs. Originally, a single, stone-lined reservoir was located in this valley below the existing Filter Building and Clarifiers/Flocculators No. 3 and No. 4. The dam for this reservoir was west of the Filter Building. As the treatment plant was expanded over the years, the two current reservoirs/dams were built in the branched valleys, the original reservoir and valley down to U.S. 27 were filled, and the existing structures were constructed. The existing Filter Building is founded on footings bearing deep below the valley fill and the original reservoir liner. The Clearwell, Clarifiers/Flocculators No. 3 and No. 4, the Sodium Hypochlorite Building, the Chemical Building and the Lab Building are supported on combinations of spread footings bearing on bedrock and drilled shafts extending through valley fill to bedrock. We are not aware of any performance issues with the existing buildings.

Available geologic mapping (Geologic Map of Parts of the Newport and Withamsville Quadrangles, KY, USGS, 1973) indicates the project site is underlain by Upper Ordovician Age bedrock of the Fairview Formation. The bedrock is noted on the Mapping to consist of interbedded shale and limestone. The shale is noted on the Map to comprise about 60 percent or more of the total and occurs in beds mostly less than ten inches thick. It is described on the Mapping as light bluish gray to medium gray (weathering dusky yellow to light olive gray), laminated to thinly bedded, calcareous, silty, and fossil poor. The limestone makes up 40 percent or less of the total, is described as medium gray, coarsely crystalline grained and fossil fragmental, in distinct beds generally less than eight inches thick, but locally as much as three feet thick. Structure contours drawn on the base of the Fairview Formation indicate relatively horizontal bedrock bedding, with a bedrock dip to the west of less than 0.5 percent. The shale and limestone percentages on the Map are averages over the entire formation thicknesses, and local variations from these average percentages do exist. No faults,

landslide activity, or geologic hazards are noted on the Map within the immediate vicinity of the project site. Kentucky Geological Survey Karst Potential Mapping indicates that the limestone units in the vicinity of the project site have low to medium potential for development of karst features.

4.0 SUBSURFACE EXPLORATION

Thelen Associates, Inc. (Thelen) personnel carried out the fieldwork phase of this exploration between December 31, 2008 and January 14, 2009. Fourteen (14) test borings, numbered 1 through 14, were drilled at the locations shown on the Boring Plan, Drawing 080978E-1, in the Appendix to this report. Test Boring 14 was terminated prior to the proposed bottom elevation due to the presence of underground utilities. The test borings were staked in the field by Thelen personnel, with the locations and surface elevations surveyed by personnel from Viox and Viox, Inc.

The test borings were advanced using a track-mounted drill rig advancing hollow stem augers. Standard Penetration Testing using split-spoon samplers was accomplished ahead of the augers following the procedures outlined in ASTM D1586. Bedrock coring was performed in selected test borings using an NXM core barrel per ASTM D2113.

As each test boring was advanced, the Drilling Technician kept a log of the subsurface profile noting the soil and bedrock types and stratifications, groundwater, penetration test results, and other pertinent data. Particular attention was given to the textures, colors, moisture contents, and consistencies of the materials encountered. Representative portions of the split-spoon samples were placed in labeled glass jars. All recovered bedrock core samples were placed in labeled plastic rock core boxes.

Groundwater measurements were made in the boreholes during drilling, at the completion of drilling, and at time intervals following the completion of drilling. These groundwater measurements are noted at the bottoms of the test boring logs. In addition, piezometers were installed in Test Borings 6 and 12 so that groundwater measurements could be made after the borehole was backfilled.

Test Borings advanced during previous geotechnical explorations performed by Thelen in 1987, 1989, 1998, and 1999 at the locations of the existing Sodium Hypochlorite Building, Flocculator/Clarifier Basin No. 4, Laboratory Building, and various pipelines were used to provide additional information about the subsurface conditions at the project site. The locations of selected test borings from these previous explorations are shown on the Boring Plan, Drawing 080978E-1, and logs of these test borings are included in the Appendix to this report.

5.0 LABORATORY TESTING AND REVIEW

The samples from the test borings were examined and visually classified in the laboratory by the Project Geotechnical Engineer. Representative samples were selected for natural moisture content determinations, Atterberg limits testing, and unconfined compression tests on bedrock. Soil classification identifications were developed in accordance with the Unified Soil Classification System (USCS). Thelen personnel performed laboratory testing in accordance with the applicable ASTM methods for soil and bedrock testing. The results of the testing are included in the Tabulation of Laboratory Tests in the Appendix along with the unconfined compressive strength test forms.

Final test boring logs were prepared by the Project Geotechnical Engineer on the basis of the visual classification in the laboratory, the laboratory test results and the field logs kept by the Drilling Technician. Copies of the final test boring logs made for this project are included in the Appendix with a Soil Classification Sheet and a Rock Weathering and Strength Classification Sheet, which describe the terms and symbols used on the boring logs. Copies of selected test boring logs from previous explorations made by Thelen at the FTTP are also provided in the Appendix.

The dashed lines on the test boring logs indicate an approximate change in soil or bedrock strata as estimated between samples. A solid line indicates a change in strata occurred within a sample where a more precise measurement could be made. The transitions between soil and bedrock types may be abrupt or gradual.

Rock Quality Designations (RQD's) were recorded for each bedrock coring run made for this project. The RQD is defined as the sum of all pieces of intact core longer than four inches in a coring run, divided by the total length of the run. This value is then multiplied by one hundred to express the result as a percentage. The RQD provides an indication of Rock Mass Quality. RQD values are presented on the Logs of Test Boring sheets in the Appendix to this report. Table 1 included below shows the correlation of RQD values with Rock Mass Quality.

Table 1. Relation of RQD to In-Situ Rock Quality*

RQD Percent	Rock Mass Quality
90-100	Excellent
75-90	Good
50-75	Fair
25-50	Poor
0-25	Very Poor

***From Naval Facilities Engineering Command, NAVFAC D.M. 7-1 (1982)**

6.0 SUBSURFACE CONDITIONS

Based on our interpretation of the geologic mapping, the results of test borings and laboratory testing, and our previous experience in the immediate area, the FTTP site was developed by excavating the terraces on the hillside at the proposed GAC Building location, and filling the adjacent drainage valley below the existing Filter Building and the two existing reservoir dams. What remains on this terraced slope are thin deposits of topsoil and reworked native clays and weathered bedrock (described as fill) over isolated thin deposits of undisturbed native clays and then the interbedded shale and limestone bedrock.

The topsoil is discontinuous across the site, but where it is present it ranges in thickness from 0.2 to 0.7 feet, with an average thickness of about 0.4 feet. The fill material ranges from 0.8 to 14.3 feet in thickness, with an average thickness of about 4.2 feet. The fill in Test Borings 11 and 13 was thicker (at 13.0 and 14.3 feet, respectively) than what was

typically encountered in the remaining test borings. Excluding Test Borings 11 and 13, the average thickness of the fill in the remaining test borings is about 2.5 feet. The fill generally consists of mixed brown, moist, medium stiff to stiff, locally soft and very stiff silty clays with topsoil, rock fragments and floaters, and hairlike roots. Natural moisture content testing of jar samples yielded values ranging from 8.3 to 30.0 percent, with an average moisture content of 21.2 percent. Four samples of this material classified as CL according to the USCS. The samples exhibited liquid limits (LL) of 43, 37, 39, and 25 percent and plasticity indices (PI) of 12, 17, 18, and 9 percent, respectively.

Undisturbed native clay soils were encountered below the fill material and above the bedrock in Borings 3, 4 and 13 in thicknesses of 2.5, 2.5, and 9.5 feet, respectively. These materials generally consisted of brown or bluish green, trace gray, moist, stiff to very stiff, locally medium stiff, silty clays or clays, with rock fragments. Natural moisture content testing of three jar samples yielded values of 18.4, 31.1, and 22.7 percent. Two samples of this material classified as CH and CL according to the USCS. The CH sample exhibited a LL of 54 percent and a PI of 21 percent. The CL sample exhibited an LL and PI of 42 percent and 21 percent, respectively.

A bedrock formation consisting of a system of interbedded shale and limestone layers was encountered below the fill and/or native soils. As previously noted, the bedrock is a system of Ordovician Aged shale and limestone, is relatively horizontally bedded, and correlates well with the Fairview Formation on the referenced mapping. Bedrock in the Northern Kentucky Area is typically characterized in three basic zones depending upon the degree of weathering. The uppermost zone is termed highly to moderately weathered interbedded shale and limestone, where the shale portion has virtually weathered to a brown silty clay or clay, yet possesses horizontally aligned bedding characteristics of the bedrock system and may contain clay seams. The intermediate zone is described as moderately to slightly weathered bedrock and is characterized by a shale component which is tougher, and generally at lower moisture contents than the shale in the highly weathered zone above. The upper and intermediate zones have weathered from the third commonly accepted zone; the gray, slightly weathered to unweathered, parent interbedded shale and limestone. The limestone beds in all three

zones are very strong and relatively unweathered compared to the shale. Because of variable weathering and erosion conditions, highly weathered and moderately weathered zones may or may not be locally present above the unweathered bedrock zone, and slightly weathered to unweathered zones may be underlain by highly to moderately weathered zones.

The top of the highly weathered bedrock zone was encountered in Test Borings 1 through 13 at depths ranging from 1.0 to 24.0 feet, with an average depth of overburden soils of 5.6 feet. It should be noted that the soil overburden depths encountered in Test Borings 11 and 13 were 13.0 and 24.0 feet, respectively. These Test Borings were located closest to the old valley fill mentioned previously. The average overburden depth is approximately 3.3 feet if these borings are not included. Moisture content testing on fifteen samples from the shale portion of the highly weathered zone yielded values ranging from 10.3 to 17.4 percent, with an average value of about 14 percent. Recovered bedrock core samples from Test Borings 3, 5, 8, and 9 in this layer were generally described as brown and/or olive brown trace gray, moist, extremely weak to weak, highly to moderately weathered, thin to medium bedded SHALE, interbedded with gray trace brown, strong to very strong, slightly weathered to unweathered, fine-to coarse-crystalline grained, thin to medium bedded, fossiliferous LIMESTONE. The RQD values for the core runs in this layer varied from 0 to 30 percent. This represents a Rock Mass Quality of "Very Poor" to "Poor".

The top of the intermediate or moderately to slightly weathered zone was encountered in Test Borings 1 through 11 at depths ranging from 7.0 to 23.0 feet below the ground surface. Moisture content testing on nineteen samples from the shale portion of the intermediate zone yielded values ranging from 7.0 and 17.0 percent, with an average value of about 11 percent. Seven selected samples of the weathered shale in the intermediate zone were subjected to unconfined compressive strength testing, yielding values ranging from 50.0 psi to 404.2 psi and averaging about 160.0 psi. Natural dry densities for these samples varied from 122.8 pcf to 144.4 pcf. Recovered bedrock core samples from Test Borings 2, 3, 5, 6, 8, 9, and 11 in this layer were generally described as gray, some brown, moist, extremely weak to weak, moderately weathered

to unweathered, thin to medium bedded SHALE, interbedded with gray, trace brown, strong to very strong, unweathered, fine-to coarse-crystalline grained, thin to medium bedded, fossiliferous LIMESTONE. The RQD values for the core runs in this layer varied from 35 to 59 percent. This represents a Rock Mass Quality of "Poor".

The upper boundary of the parent, slightly weathered to unweathered gray shale and limestone bedrock was encountered in Test Borings 3, 5, 6, and 9 below depths ranging from 33.0 to 48.0 feet. Moisture content testing on seven samples from the shale portion of the parent bedrock yielded values ranging from 4.8 to 10.1 percent, with an average value of about 7 percent. Additionally, seven selected samples of the slightly weathered to unweathered shale of the parent bedrock were subjected to unconfined compressive strength testing, yielding values ranging from 71.5 psi to 741.7 psi and averaging about 340 psi. These shale strengths are on the low-end of the range of strengths typically found for shales throughout the Northern Kentucky region. The strengths of shales in Northern Kentucky typically range from about 200 psi to more than 4,000 psi, and it should be assumed that strengths of shales for this project will be throughout this wider range. Natural dry densities for the tested samples varied from 136.2 pcf to 158.9 pcf. Recovered bedrock core samples from Test Borings 3, 5, 6, and 9 in this layer were generally described as gray trace brown, moist, extremely weak to weak, slightly weathered to unweathered, thin to medium bedded SHALE, interbedded with gray, strong to very strong, unweathered, fine-to coarse-crystalline grained, thin to medium bedded, fossiliferous LIMESTONE. The RQD values for the core runs in this layer varied from 9 to 52 percent. It should be noted that a piece of limestone stuck in the core barrel in one of the runs from Test Boring 3 and disintegrated most of the rock within this layer during coring. The RQD values of the other test borings within this layer exhibited an average value of about 48 percent, which corresponds to a Rock Mass Quality of "Poor".

The limestone layers in all three zones of the bedrock discussed above are relatively unweathered and strong compared to the shale. Ten (10) selected samples of the limestone from all three zones were subjected to unconfined compression testing, yielding values ranging from 2,158 psi to 15,505 psi, and averaging 10,357 psi. These

strengths are in the lower to middle part of the range of limestone strengths typically found in Northern Kentucky. The typical range of limestone strengths is about 2,000 psi to 21,000 psi, and it should be assumed that the limestone strengths will be throughout this typical range for this project. No indications of karstic solutioning were encountered within the bedrock samples collected.

The United States Geological Survey Map for the project area (USGS Map of Parts of the Newport and Withamsville Quadrangles, KY., 1973) indicates that, on the average over the full formation thickness, the Fairview Formation Bedrock is comprised of 60 percent or more shale and 40 percent or less limestone, with the limestone layers generally less than 8 inches thick, but locally as much as 3 feet thick. Local variations in the percentage and thickness of limestone layers do exist. For this project, limestone percentages and thicknesses were evaluated over core lengths ranging from 2 feet to 10 feet, most frequently 5 feet. Limestone percentages over these lengths varied from 18 to 55 percent, and averaged about 37 percent. Limestone layer thicknesses range from less than one (1) inch to 12 inches.

7.0 GROUNDWATER

Based on our local experience, groundwater seepage can occur at the fill soil/native soil interface, at the native soil/bedrock interface, and along limestone layers within the bedrock. Groundwater was measured in the piezometer in Test Boring 6 at a depth of about 38 feet below ground surface at 90 days after completion of drilling. No groundwater was measured in the piezometer in Test Boring 12 during this period. A consistent groundwater table was not identified within the test borings. In our opinion, isolated seepage zones were encountered, which is typical for the bedrock profile, and indicative of the groundwater springs that have periodically been noted on the hillside by NKWD personnel. It should be noted that drilling operations were conducted in the months of December and January, a regionally wet period. There may be seasonal fluctuations of the groundwater table based on temperatures and/or precipitation amounts. Individual groundwater readings can be found at the bottoms of the test boring logs in the Appendix to this report.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 General

Based upon the test borings, a visual examination of the samples, the laboratory tests, our understanding of the proposed construction, and our experience as Consulting Soil and Foundation Engineers in the Northern Kentucky Area, we have reached the conclusions and make the recommendations in this report.

If conditions are encountered in the field during construction which vary from the facts of this report, we recommend that our office be contacted immediately to review the changed conditions in the field and make appropriate recommendations.

The scope of our services did not include any environmental assessment or investigation for the presence or absence of wetlands or hazardous or toxic materials in the soil, bedrock, surface water, groundwater or air, on or below or around this site.

We have performed the test borings and laboratory tests for our evaluation of the site conditions and for the formulation of the conclusions and recommendations of this report. We assume no responsibility for the interpretation or extrapolation of the data by others.

The earthwork recommendations of this report presume that an Engineering Technician under the direction of a Registered Professional Engineer will monitor the earthwork continuously. We recommend that the Owner contract these services directly with Thelen Associates, Inc.

We recommend that a preconstruction meeting be held at the site with the Owner's representative(s), the Design Engineer, the Project Structural Engineer, the General Contractor, the Excavating Contractor, the Geotechnical Engineer and any other interested parties to review the scope and schedule of the proposed earthwork and foundation installation.

8.2 Subsurface Conditions and Seismicity

The project site is generally underlain by cohesive fill material, followed by discontinuous native clay soils and finally interbedded shale and limestone bedrock. The GAC Building will bear in the bedrock.

Based on the test borings and our interpretation of Kentucky Building Code 2007 Edition (KBC 2007) and its approved amendments to date, it is our opinion that the following seismic parameters will be applicable for the proposed GAC Building:

Site Class	B
S_S	0.179g
S_1	0.075g

Site Class B is representative of a subsurface profile predominantly consisting of bedrock exhibiting a shear wave velocity (V_s) in the range of 2,500 to 5,000 feet per second.

8.3 Site Preparation and Earthwork Operations

8.3.1 Excavations

Grading for this project will include a deep excavation into the existing hillside to reach subgrade elevation for the GAC Building. Maximum cuts required on the east side of the proposed GAC Building are anticipated to be on the order of 65 feet deep, down to approximate elevation 742 feet, MSL. Other shallow cuts may be required to achieve subgrade elevation for the proposed parking and/or driveway areas. The excavations will extend through thin deposits of fill and native clay soils containing limestone fragments and floaters, then through the highly to moderately weathered upper zone of the interbedded shale and limestone bedrock, then through the intermediate moderately to slightly weathered bedrock zone, and into the slightly weathered to unweathered zone of the bedrock. The difficulty of completing excavations in the bedrock will exceed the difficulty of excavating in the fill and native overburden soils. Additionally, the difficulty of excavating in the bedrock will increase with depth into the bedrock, primarily

related to the frequency, thickness and strength of the limestone layers in the bedrock and the strength and degree of weathering of the shale.

In our opinion, the excavation through the clayey soils and into the bedrock can be made with mechanical excavating equipment, such as (but not limited to) large trackhoes with ripping teeth, ramhoes, rock saws and jackhammers. The Contractor should select a method of excavating the bedrock that will protect nearby structures and infrastructure from vibration damage or other damage that may be caused during bedrock excavation. The specifications should require a preconstruction survey of all nearby structures and properly to document existing conditions before any excavations are made. The specifications should also require vibration monitoring of nearby structures as the excavations are made, and adjustments to the excavation methods as necessary to maintain vibrations of existing structures below threshold limits for structural damage.

Because of the close proximity of existing structures to the proposed excavation, we recommend that blasting not be permitted for this project.

We recommend that the Contractor be responsible for the stability and safety of all excavations, and should exercise all necessary caution to shore, slope, brace or otherwise maintain stable and safe excavations to protect workers in the excavations as well as people and property adjacent to, above, and upslope of excavations. All Federal, State and Local safety regulations should be satisfied. In our opinion, temporary excavations in the lowest zone of the bedrock (the unweathered, parent, interbedded gray shale and limestone) can be made with vertical cuts; temporary excavations in the intermediate moderately to slightly weathered zone of the bedrock should be made with slopes of 0.5 horizontal to 1.0 vertical (0.5H:1V) or flatter; temporary excavations in the upper highly to moderately weathered zone of the bedrock should be made with slopes of 1H:1V or flatter; and temporary excavations in the native clay soils and fill soils should be made with slopes of 2H:1V or flatter.

Rockfalls and the tumbling of slaked shale to the bottom of the cut are common on cut slopes within the interbedded shale and limestone bedrock in the Northern Kentucky Area. Therefore, we recommend that the temporary cut slopes for this project be draped with a heavy wire mesh (similar to chain link fence material) to reduce the risk of damage or injury from rockfalls or slaking.

It is expected that groundwater seeps may become evident within the bedrock as the GAC Building excavation proceeds. Groundwater seeps should be brought to the attention of the Project Engineer for evaluation. During the construction of the GAC Building, the Contractor should be prepared to collect and dispose of the groundwater in order to maintain the base of the excavation in a relatively dry condition prior to backfill operations. We recommend that a contingency be included in the construction documents for evaluation and remediation of groundwater seeps. After backfilling is complete, it is our understanding that groundwater from potential seeps will be collected in a drainage system which is discussed in subsequent sections of this report.

The earthwork for this project consists predominantly of the bedrock excavation; there are no substantial structural fills for the project and there is no designated waste fill area on or near the project site. Therefore, most of the excavated material will have to be hauled off-site for disposal. It will be beneficial to limit the overdig around the structure, within the limitations of excavation safety and project constructability, in order to reduce the volume of excavation and off-site disposal.

8.3.2 Structural Fill

All proposed cut, fill, pavement and development areas at the site should be cleared of all building debris and remnants of prior construction. Vegetation and the heavy root system (and all topsoil) should be stripped. The vegetation should be wasted off site. The asphalt and/or concrete pavement should similarly be stripped and wasted off site. The topsoil can be stockpiled for re-use in final grass and landscape areas, if permitted by specification.

It should be expected that some undercutting, moisture conditioning and recompaction of existing low-strength, low-density fill soils, low-strength native cohesive soils, and/or building debris associated with the remnants of existing pavements removed during the excavation for the GAC Building will be required. If these low-strength materials are encountered within the limits of the entrance drives or the proposed parking areas, they should be undercut and replaced with compacted and tested cohesive soils. We recommend that the contract documents include an item for undercutting of such materials as deemed necessary, and their replacement with new compacted and tested fill on a per cubic yard of in-place compacted replacement fill basis.

We recommend that all new fill soils in paved or yard areas consist of on-site, clean, low-plasticity, cohesive soils relatively free of topsoil, vegetation, trash, construction or demolition debris, organic soils, frozen materials, particles more than 2 inches maximum diameter or other deleterious materials. The plasticity index of the fill soils should be 24 percent or less. The fill soils may be silty clays from on-site cuts that meet these criteria, or the moderately to highly weathered shales from the cuts, provided that they are pulverized to a soil-like consistency, meet the previously mentioned plasticity requirements, and are moisture-conditioned the same as a soil fill. New fills should be placed on the prepared surfaces in shallow horizontal layers, 6 to 8 inches in loose thickness. The fill should be compacted to at least 95 percent of the maximum dry density determined by the standard Proctor moisture-density test, ASTM D698. The moisture content of the fill at the time of compaction should be maintained within 2 percent below to 3 percent above the optimum moisture content. Soils within 12 inches of pavement subgrade elevation should be moisture conditioned to within two percent of the optimum moisture content and compacted to densities not less than 100 percent of the standard Proctor maximum dry density, ASTM D698, immediately prior to placing the pavement. The subgrade soils should be proofrolled with a fully loaded, single axle dump truck in the presence of the Engineer or his representative to determine that the soils are firm and non-yielding. Any soft or yielding soils detected by the proofrolling should be removed and replaced with compacted and tested fill that is firm, non-yielding, and meets the recommended moisture-density criteria.

Fill on sloping terrain should be placed and compacted on successive horizontal benches that begin at the toe of the fill slope. The horizontal benches should be cut at least 2 feet deep below the existing ground surface, and deeper as necessary to satisfy the undercut and proofroll recommendations provided above.

It is very important that good, positive drainage be established around the structures to promote the rapid drainage of surface water away from the buildings. Finish grading in grass or landscaped areas should be sloped down and away from the structures at 5 percent for at least 10 feet, and then at least 2 percent thereafter. Storm water falling on pavements should be collected in a storm sewer system and properly disposed. Additionally, storm water should not be allowed to enter the site from adjacent properties, specifically from the east where Southview Avenue terminates above the proposed GAC Building site. The stormwater from Southview Avenue should be collected and diverted at the beginning of the project, so that it does not flow either into the temporary excavation or toward the completed building.

All areas disturbed during the proposed construction should be seeded, mulched or paved as soon as possible after construction so as to minimize surface erosion. During construction, straw bales or silt fences should be staked across areas of concentrated runoff to minimize the washing of silt onto adjacent properties or into drainage swales.

Experience has found that the optimum season of the year for earthwork in the Northern Kentucky Area is during the months of June through October because of the historically more favorable weather conditions during that period. If construction is to be performed during the winter or early spring months, care should be taken so that no concrete, asphalt, or new fills are placed over frozen or saturated soils. Additionally, frozen or saturated soils should not be used for compacted fill or backfill.

Recommendations for structure and utility backfill for the GAC Building/EQ Tanks and associated supply/discharge pipelines are provided in Section 8.5 of this report.

8.4 Foundation Recommendations

The GAC Building will have multiple bearing levels that vary from approximate elevations 742 feet to 767 feet along its length. The foundations bearing at these elevations are expected to be reinforced concrete mat foundations. The bearing materials expected at the various elevations will range from highly weathered shale and limestone bedrock, to moderately weathered shale and limestone bedrock, to unweathered shale and limestone bedrock. Recommended allowable bearing capacities for design under full dead and full live load are shown in Table 2.

Table 2. Allowable Bearing Capacities of Bedrock

Bedrock Description	Allowable Bearing Capacity, psf
Highly Weathered Shale and Limestone Bedrock	6,000
Moderately Weathered Shale and Limestone Bedrock	12,000
Slightly Weathered to Unweathered Shale and Limestone Bedrock	30,000

The depths of the weathered zones described in Section 6.0 of this report are illustrated on Cross Sections A-A, B-B and C-C (Drawings 080978E-2 through 080978E-4, respectively) in the Appendix to this report. Because the thickness of the limestone bedrock layers was variable and did not consistently increase with depth below ground surface, a relationship between bedrock bearing capacity and RQD is not made.

The bedrock surface elevation drops across the site in a northerly direction toward the previously mentioned buried valley beneath the existing Flocculator/Clarifier Basin No. 4. It is anticipated that the north end of the GAC Building will bear at roughly elevation 767 feet, MSL. It is expected that the bedrock surface will be higher than elevation 767 feet (MSL) at the north end of the proposed Building, and that the required excavations will expose the interbedded highly weathered shale and limestone bedrock. However, if fill material or native soil overburden is encountered at or below the subgrade elevation at this location, we recommend that the foundation excavations be deepened to expose bedrock, that horizontal bearing surfaces be prepared on the bedrock in the bottoms of

the overexcavations, and that lean concrete be used to backfill the overexcavations up to design foundation bearing level, as discussed below.

We recommend that all bearing surfaces be covered with a thin concrete "mud mat" to protect the bedrock from excessive wetting or drying and disturbance related to construction of reinforcing steel. The "mud mat" concrete should have a 28-day compressive strength of at least 1500 psi. Prior to placing any concrete "mud mat", reinforcing steel or foundation concrete, the bearing surfaces should be cleaned of all loose, wet or otherwise disturbed material to expose firm, intact, undisturbed bedrock. Intact limestone encountered at subgrade elevations may remain in place provided that it can be determined that the limestone has not been disturbed and that the surrounding shales have not softened due to prior groundwater seepage. Disturbed pieces of limestone and water softened shales should be removed from the bearing surfaces before the "mud mat" is placed. We recommend that the bearing surfaces be reviewed by the Project Geotechnical Engineer or his representative before the "mud mat" is placed to determine that the bearing materials and bearing surfaces are consistent with the recommendations in this report and the intent of the design.

The lower levels of the GAC Building will have multiple transitions between bearing levels. The over-excavation of the bedrock at these steps will result in the higher levels either partially bearing on backfill in the annular space, or structurally spanning the area. We recommend that the excavations be made as small as possible (without affecting constructability) in order to minimize the widths of the annular backfill or structural spans. The bearing capacity of the annular backfill will always be less than the allowable bedrock bearing capacity, unless the over-excavations are backfilled with lean concrete. Because of the swell (expansion) potential of the shale portion of the bedrock, we recommend that these excavations not be backfilled with undrained granular backfill. We recommend that the over-excavations be backfilled with lean concrete with a minimum 28-day compressive strength of at least 1500 psi.

As mentioned above, previous geotechnical explorations for the existing Flocculator/Clarifier Basin No. 4 and Laboratory Building were conducted by Thelen in

1989 and 1998, respectively. Construction drawings provided by the Designer and test boring data from the exploration for the Laboratory Building indicates that the reinforced concrete building foundations bear on bedrock at about elevation 769 feet, MSL. Additionally, it is our understanding that the Flocculator/Clarifier Basin No. 4 has a floor at about elevation 765.0 (MSL), and is supported on a grid pattern of drilled shafts bearing on bedrock. In our opinion, the bedrock bearing foundations of these structures and the distances from the proposed GAC Building excavations to these existing structures allow the excavations to be advanced without the need for shoring or underpinning of these two adjacent structures.

As noted in Section 2.0 of this report, it is our understanding that a proposed Flow Splitter Box, expected to be about 20 feet x 27 feet in plan dimension, will be constructed roughly 30 feet from the northwest corner of the proposed GAC Building. We further understand that this structure is designed to have a subgrade elevation of approximately 766.0 feet MSL. Test Boring data from a previous geotechnical exploration in 1989 indicates that the surface of the highly weathered shale and thinly bedded limestone bedrock ranges between approximate elevations 763.0 and 765.0 feet (MSL) in the vicinity of the proposed Flow Splitter Box. We recommend that the foundations for this structure be deepened to bear within the bedrock at this location to minimize potential differential settlement that may be experienced by bearing in the overlying variable quality fill materials. Recommended allowable bearing capacities for design under full dead and full live load are shown in Table 2.

8.5 Structure and Utility Backfill Materials

After the walls of the GAC Building have been completed and properly braced, the structure should be backfilled with approved borrow materials placed and compacted in shallow, level layers, 6 to 8 inches in thickness. We recommend that free-draining granular backfill with a compacted clay surface cap be used above drain level and lean concrete backfill be used below drain level (see discussion in Section 8.6 below). Each backfill layer should be compacted to a density not less than 95 percent of the standard Proctor maximum dry density (ASTM D698) for clays and granular soils that have a well-defined moisture-density relationship, and not less than 75 percent relative density

(ASTM D4253 and D4254) for granular soils that do not have a well-defined moisture-density relationship. All clayey soil materials used as backfill should be moisture conditioned to within a range of 2 percent below to 3 percent above the optimum moisture content for compaction. The type and weight of compaction equipment should be carefully selected so as to achieve the compaction while not overstressing the structure walls.

Normal and recommended utility construction practice is to bed and backfill pipes with granular fill to at least 6-inches above the crown of the pipe, and then complete the backfilling up to ground surface with well-compacted clay soils. Compaction of trench backfill to a moist, firm, dense condition is important for all pipelines. We recommend that all pipeline backfill for this project be placed in shallow level layers, 6 to 8 inches in thickness, and compacted to densities not less than 95 percent of the standard Proctor maximum dry density (ASTM D698). We recommend that pipe trench granular backfill be limited to pipe bedding and to 6-inches above the pipe, except where those pipes are within free-draining granular backfill for a structure. All granular backfill should be compacted to at least 75 percent relative density, per ASTM D4253 and D4254. Under no circumstances should any backfill be flushed to obtain compaction.

The excavations for all utility/pipe trenches must be made in a manner that provides for the safety of workers in the excavations and protects existing ground, structures, and infrastructure adjacent to the excavations from damage. The excavations should be braced, shored, sloped, or otherwise stabilized in a manner that satisfies all safety concerns and all federal, state, and local regulations. The responsibility of maintaining safe working conditions in the excavations and for protecting ground, structures, and infrastructure adjacent to the excavations should be the Contractors. Additionally, the Contractor should be responsible for maintaining the stability of all existing utilities during the installation of utility/pipelines.

As noted in Section 4.0 of this report, Test Boring 14 was terminated prior to the proposed bottom elevation due to conflicts with existing buried utilities. Test borings advanced in 1987 and 1999 at the locations of existing pipelines and the Sodium

Hypochlorite Building indicate that the surface of the highly weathered shale and thinly bedded limestone bedrock may be encountered below approximate El. 763.0 feet, MSL. The locations of selected test borings from these previous explorations are shown on the Boring Plan, Drawing 080978E-1, and logs of these test borings are included in the Appendix to this report.

8.6 Lateral Earth Pressures and Buoyancy

The below-grade structure walls should be designed to accommodate lateral earth pressures plus all applicable ground surface surcharges (such as slopes up and away from the walls and wheel loads of delivery trucks). It is our understanding that the GAC Building will be constructed so that interior walls and/or floors will restrict potential wall movement, resulting in at-rest earth pressure conditions. We further understand that a drainage system will be incorporated into the backfill, with an approximate invert elevation of 767.0 feet (MSL), and will drain into the proposed EQ Tank. The drain pipe outlet to the EQ Tank should have a backflow prevention valve to prevent flow of water from the EQ Tank to the drain system and backfill. The backfill above the drain invert should consist of compacted free-draining granular material with a 2-feet thick clay surface cap to prevent surface water infiltration. The backfill below the drain invert level should consist of lean concrete.

Specifically, the drainage system should consist of free-draining granular backfill with less than three (3) percent particle sizes passing the No. 200 sieve. The free-draining granular backfill should be separated from the compacted clay cap and from the shale and limestone bedrock with a non-woven geotextile filter fabric, such as Mirafi 140N, specifically designed for filtration. Monitoring wells should be installed to ensure that the groundwater level does not exceed the invert elevation of the backfill drain system.

Assuming a drainage system is provided, and all backfill except the clay cap is granular soil, we recommend using an Equivalent Fluid Weight (EFW) of 57 pounds per cubic foot (pcf) from the ground surface down to the bottom of the drainage system.

All foundation walls below the level of the drain system should be backfilled with lean concrete with a 28-day compressive strength of at least 1500 psi. Granular backfill should not be used as backfill in these areas. We recommend using an EFW of 62.4 pcf for backfill below the drain system to the bottom of the foundations. However, the height of the lifts of lean concrete backfill have to be limited so that the capacity of the wall is not exceeded while the lean concrete fill is fluid.

The structure should be designed to resist buoyant uplift forces, assuming that water can build up around the structure to the level of the drain system. The resistance to uplift should be provided by a combination of the dead weight of the structure, dead weight of any soil/concrete backfill atop foundation projections beyond the structure walls, frictional resistance around the perimeter of the structure and/or tie-down anchors.

The frictional resistance around the perimeter can be estimated with an ultimate friction factor of 0.3 for the select granular backfill above the drain level. An adequate factor of safety should be applied to this ultimate friction factor.

Tie-down anchors with bond zones in the unweathered bedrock beneath the structure could be designed for an allowable anchor bond stress of 25 pounds per square inch (psi) between the anchor grout and the bedrock, provided the design anchor capacities are confirmed by performance and proof-load testing during construction. The performance and proof-load testing should be in accordance with Post-Tensioning Institute criteria or other approved industry standards. The performance and proof-load testing procedures should be clearly outlined in the project specifications.

8.7 Pavements

Pavements for this project should be designed in accordance with expected axle loads, frequency of loading and the properties of the subgrade. The subgrade properties should be evaluated by field CBR or plate load tests after final grading is completed or by the correlation of field density tests to laboratory CBR tests. In each case, we recommend that the upper 12 inches of subgrade be compacted within 2 percent of

optimum moisture content to at least 100 percent of maximum density as determined by the standard Proctor moisture-density test, ASTM D698.

We recommend that if a dumpster will be used at the project site, the dumpster should be supported on a concrete slab and the slab should be sized to accommodate the loading wheels of the dumpster truck. In addition, pavements servicing dumpsters should be designed for the heavier loads associated with the dumpster trucks.

Surface drainage should be directed away from the edges of proposed or existing pavements so that water does not pond next to pavements or flow onto pavements from unpaved areas. Such ponding or flow can cause deterioration of pavement subgrades and premature failure of pavements. If drainage ditches are used to intercept surface water before it reaches the pavements, the ditches should have an invert at least 6 inches below the pavement subgrade, and have a longitudinal gradient that causes the ditches to drain rapidly and not pond water. If these criteria cannot be met, consideration should be given to incorporating edge drains into the pavement design.

The off-site disposal of the excavated material for this project will result in a larger-than-normal amount of construction truck traffic on the existing FTTP access road. This should be taken into consideration in the assessment of potential damage to the existing road during construction of the GAC Building.

It should be noted that the proposed widening of the main entrance driveway from the security gate to the lower Laboratory Building parking lot, and the associated retaining wall, were beyond the scope of services for this exploration and report. We recommend that two additional borings be advanced in the area of the proposed widening with results and geotechnical recommendations included in an Addendum to this report.

8.8 Retaining Wall

As noted in Section 2.0 of this report, a proposed retaining wall roughly 130 feet in length will be constructed along the slope below the northwest corner of the existing Filter Building and above the existing round Clearwell structure. This retaining wall

structure was not included in the scope of work for the exploration and test borings were not advanced in this area. Further, no test borings from previous explorations have been advanced along the proposed wall location. We recommend that three additional test borings be advanced along the location of the retaining wall structure with results and geotechnical recommendations included in an Addendum to this report.

8.9 Pipeline Discharge Structure

As previously discussed, a new pipeline discharge headwall structure will be constructed on the south bank of the south reservoir where the EQ Pump Station force main terminates. This structure was not included in the scope of work for this exploration and no test borings (current or from previous explorations) have been advanced at this location. We recommend one test boring be advanced at the proposed structure location with results and geotechnical recommendations provided in an Addendum to this report.

9.0 CLOSURE

The conclusions and recommendations of this report have been derived by relating the general principles of the discipline of Geotechnical Engineering to the proposed construction outlined by the Project Characteristics section of this report. Because changes in surface, subsurface, climatic, and economic conditions can occur with time and location, we recommend for our mutual interest that the use of this report be restricted to this specific project.

Our understanding of the proposed design and construction is based on the documents and information provided to us at the time this report was prepared and which are referenced in the Project Description section of this report. We recommend that our office be retained to review the final design documents, plans, and specifications to assess any impact changes, additions or revisions in these documents may have on the conclusions and recommendations of this Geotechnical Report. Any changes or modifications which are made in the field during the construction phase which alter site grading, structure locations, infrastructure or other related site work should also be reviewed by our office prior to their implementation.

Recommendations have been provided in the various sections of this report. The report shall, therefore, be used in its entirety. The Designer should see that all parties have the entire report with all possible supplementary information for their respective use and that they understand the intent of the contents. This report is not a bidding document and shall not be used for that purpose. Anyone reviewing this report must interpret and draw conclusions regarding specific construction techniques and methods each chooses to use.

APPENDIX

ASFE Report Information

Tabulation of Laboratory Tests

Unconfined Compressive Strength Test Forms - Rock

Test Boring Logs, 080978E

Test Boring Logs, 87343E, 89079E, 980640E, and 990146E

Soil Classification Sheet

Rock Weathering and Strength Classification Sheet

Boring Plan, Drawing 080978E-1 (In Pocket)

Cross Sections, Drawings 080978E-2 through 080978E-4 (In Pocket)

Important Information about Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

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GEOTECHNICAL EXPLORATON
ADVANCED TREATEMENT GAC
NKWD FT. THOMAS TREATMENT PLANT
FT. THOMAS, KENTUCKY
080978E

TABULATION OF LABORATORY TESTS

Boring No.	Sample No.	Depth (ft) From	Depth (ft) To	Moisture Content (%)	Atterberg Limits (%) LL	PL	PI	Natural Dry Density (pcf)	Unconfined Compressive Strength (ksf)	Unconfined Compressive Strength (psi)	USCS Classification
1	1	0.0	1.5	25.6							
	2	2.5	2.7	16.6							
	3	5.0	5.9								
	4	7.5	9.0	16.7							
	5	10.0	10.2								
	6	12.5	13.8	15.6							
	7	15.0	15.4								
2	1A	0.0	0.2								
	1B	0.2	1.5	21.4							
	2	2.5	2.7								
	3	5.0	5.2	0.2							
	4	7.5	8.5								
	5	10.0	11.0	11.9							
	RC-7	13.5	13.8	13.1				122.8	9.9	69	
	RC-8	21.3	21.8	0.2				164.5	748.9	5,201	
	RC-10	30.8	31.3	11.0				131.8	16.8	117	
	RC-11	34.1	34.6	0.3				162.7	2232.8	15,505	
3	1A	0.0	0.2	31.7							
	1B	0.2	1.5	27.5							
	2	2.5	4.0								
	3	5.0	6.5	18.4	54	23	31				CH
	4	7.5	9.0								
	5	10.0	11.0	11.0							
	6	12.5	13.4								
	RC-9	23.3	23.7	0.1				168.2	2176.8	15,117	
	RC-10	29.6	30.2	9.9				133.5	22.3	155	
	RC-11	35.8	36.3	0.7				165.2	310.8	2,158	
	RC-13	48.0	48.4	4.8				158.9	106.8	742	

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GEOTECHNICAL EXPLORATON
ADVANCED TREATEMENT GAC
NKWD FT. THOMAS TREATMENT PLANT
FT. THOMAS, KENTUCKY
080978E

TABULATION OF LABORATORY TESTS

Boring No.	Sample No.	Depth (ft) From	Depth (ft) To	Moisture Content (%)	Atterberg Limits (%) LL	Atterberg Limits (%) PL	Atterberg Limits (%) PI	Natural Dry Density (pcf)	Unconfined Compressive Strength (ksf)	Unconfined Compressive Strength (psi)	USCS Classification
3 (cont)	RC-13	52.0	52.3	10.1				136.2	10.3	72	
4	1	0.0	1.5	29.6							
	2	2.5	4.0	22.2							
	3	5.0	6.5								
	4	7.5	9.0	31.1							
	5	10.0	11.5								
	6	12.5	13.2	13.0							
	7	15.0	16.0								
	8	17.5	17.7	10.6							
	9	20.0	21.5								
	10	22.5	23.0	17.0							
	11	25.0	25.9	11.9							
	12	30.0	30.5	10.6							
	13	35.0	35.5	13.0							
	14	40.0	40.4	10.1							
	15	45.0	45.1	8.2							
5	1	0.0	1.5	8.3							
	2	2.5	3.5								
	3	5.0	5.5	12.0							
	RC-5	13.4	14.3	14.4				127.1	7.2	50	
	RC-5	16.2	16.7	0.2				168.4	1119.6	7,775	
	RC-8	31.6	32.1	13.2				128.3	7.2	50	
	RC-9	34.2	34.7	0.3				166.3	1612.9	11,201	
	RC-10	40.7	41.2	7.7				142.0	41.1	285	
	RC-11	44.7	45.2	9.5				136.8	16.8	117	
	RC-11	46.1	46.5	4.8				144.2	13.9	97	
6	1A	0.0	0.2								

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FT. THOMAS, KENTUCKY
080978E

TABULATION OF LABORATORY TESTS

Boring No.	Sample No.	Depth (ft)		Moisture Content (%)	Atterberg Limits (%)			Natural Dry Density (pcf)	Unconfined Compressive Strength (ksf)	Unconfined Compressive Strength (psi)	USCS Classification
		From	To		LL	PL	PI				
6 (cont)	1B	0.2	1.5	17.2	43	22	12				CL
	2	2.5	3.4								
	3	5.0	6.2	14.0							
	4	7.5	8.5								
	5	10.0	10.5	9.5							
	RC-15	54.3	54.7	0.1				168.4	1972.8	13,700	
	RC-15	55.5	56.0	6.3				146.4	98.0	681.0	
7	1A	0.0	0.4								
	1B	0.4	1.5	23.5							
	2	2.5	3.2								
	3	5.0	6.5	13.5							
	4	7.5	9.0								
	5	10.0	11.3	11.7							
	6	12.5	12.7								
	7	15.0	15.4	10.8							
8	1A	0.0	0.7	25.8							
	1B	0.7	1.5	18.4							
	2	2.5	4.0								
	3	5.0	6.0	14.2							
	RC-7	24.2	24.9	7.0				144.4	33.4	232	
	RC-7	26.5	27.0	0.2				169.0	1581.4	10,982	
9	1A	0.0	0.4	26.9							
	1B	0.4	1.5	30.0							
	2	2.5	4.0	15.5							
	3	5.0	5.5								
	RC-5	13.6	14.0	7.9				139.3	58.2	404	
	RC-7	25.2	25.6	0.5				164.1	1725	11,979	

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TABULATION OF LABORATORY TESTS

Boring No.	Sample No.	Depth (ft)		Moisture Content (%)	Atterberg Limits (%)			Natural Dry Density (pcf)	Unconfined Compressive Strength (ksf)	Unconfined Compressive Strength (psi)	USCS Classification
		From	To		LL	PL	PI				
9 (cont)	RC-8	29.8	30.2	0.2				166.5	1432.5	9,948	
	RC-9	33.4	33.9	12.5				130.5	13.6	94	
	RC-12	48.3	48.8	5.6				148.9	57.2	397	
	RC-13	54.6	55.0								
10	1A	0.0	0.7	26.9							
	1B	0.7	1.5	23.5							
	2	2.5	4.0	10.3							
	3	5.0	5.5								
	4	7.5	8.0	8.1							
	5	10.0	11.0								
11	1	0.0	1.5	18.3							
	2	2.5	4.0	18.1	37	20	17				CL
	3	5.0	6.5								
	4	7.5	9.0	21.3							
	5	10.0	11.5								
	6A	12.5	13.5	15.5	39	21	18				CL
	6B	13.5	14.0								
12	1A	0.0	0.2	36.8							
	1B	0.2	1.0	26.4							
	1C	1.0	1.5								
	2	2.5	4.0	13.9							
	3	5.0	5.5								
	4	7.5	7.7								
13	1A	0.0	0.2	31.4							
	1B	0.2	1.5								
	2	2.5	4.0	13.9							

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NKWD FT. THOMAS TREATMENT PLANT
FT. THOMAS, KENTUCKY
080978E

TABULATION OF LABORATORY TESTS

Boring No.	Sample No.	Depth (ft) From	Depth (ft) To	Moisture Content (%)	Atterberg Limits (%) LL	Atterberg Limits (%) PL	Atterberg Limits (%) PI	Natural Dry Density (pcf)	Unconfined Compressive Strength (ksf)	Unconfined Compressive Strength (psi)	USCS Classification
13 (cont)	3	5.0	6.5								
	4	7.5	9.0	21.6	25	16	9				CL
	5	10.0	11.5								
	6	12.5	14.0	15.1							
	7	15.0	16.5								
	8	17.5	19.0	22.7	42	21	21				CL
	9	20.0	21.5								
	10	25.0	26.5	17.4							
	11	30.0	31.0	9.0							
14	1	0.3	1.2	6.3							
	2	2.5	4.0	4.4							
	3	5.0	6.5	5.9							

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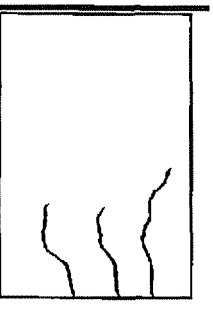
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 2 SAMPLE NUMBER: RC DEPTH (ft.): 13.5-13.8
SAMPLE DESCRIPTION: Gray and Brown moderately weathered shale
BEDROCK FORMATION: Fairview Formation DATE: 1/19/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.85
HEIGHT (in.)	3.28
HEIGHT TO DIAMETER RATIO	1.77
AVERAGE AREA (sq. ft.)	0.0187
VOLUME (cu. ft.)	0.0051
WET WEIGHT (lbs.)	0.71
DRY WEIGHT (lbs.)	0.63
DRY DENSITY (pcf)	**122.8**

FAILURE SHAPE

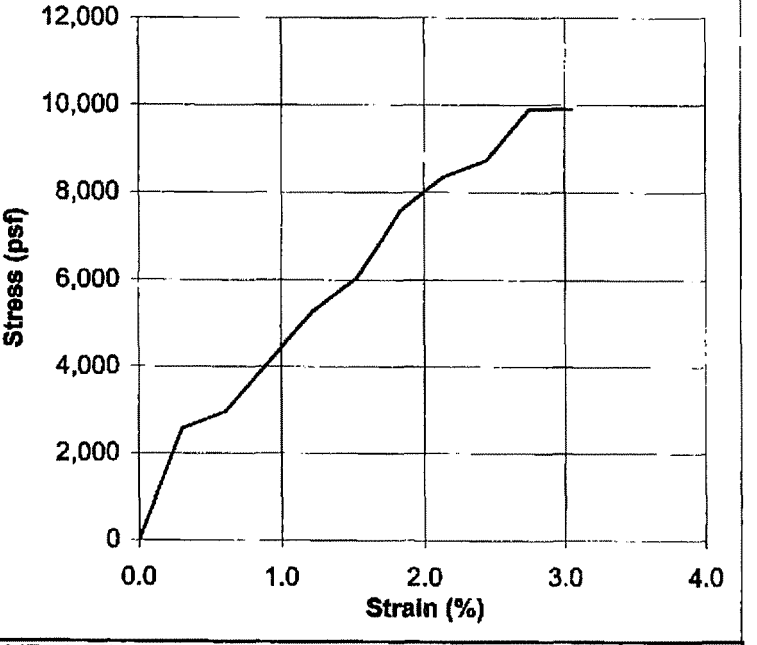


WATER CONTENT AFTER SHEAR	
CAN NUMBER	x8
WET WEIGHT + CAN (lbs.)	0.95
DRY WEIGHT + CAN (lbs.)	0.86
WEIGHT WATER (lbs.)	0.08
WEIGHT CAN (lbs.)	0.24
WEIGHT SOLID (lbs.)	0.63
MOISTURE (%)	**13.1**

PROVING RING NO.: 19901

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
10	1	48	0.3	2,572
20	2	55	0.6	2,958
30	5	77	0.9	4,114
40	8	98	1.2	5,270
50	10	113	1.5	6,041
60	14	142	1.8	7,582
70	16	156	2.1	8,353
80	17	163	2.4	8,739
90	20	185	2.7	9,895
100	20	185	3.0	9,895

TEST TEMPERATURE: 70°F



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**1.5**
STRAIN AT FAILURE (%)	**2.7**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**9.9**
SHEAR STRENGTH (ksf)	**4.9**

REMARKS :

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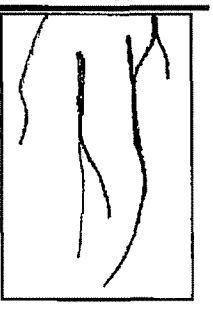
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 2 SAMPLE NUMBER: RC DEPTH (ft.): 21.3-21.8
SAMPLE DESCRIPTION: Gray and Brown slightly weathered limestone
BEDROCK FORMATION: Fairview Formation DATE: 2/19/2008
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.86
HEIGHT (in.)	4.42
HEIGHT TO DIAMETER RATIO	2.38
AVERAGE AREA (sq. ft.)	0.0188
VOLUME (cu. ft.)	0.0069
WET WEIGHT (lbs.)	1.14
DRY WEIGHT (lbs.)	1.14
DRY DENSITY (pcf)	**164.6**

FAILURE SHAPE

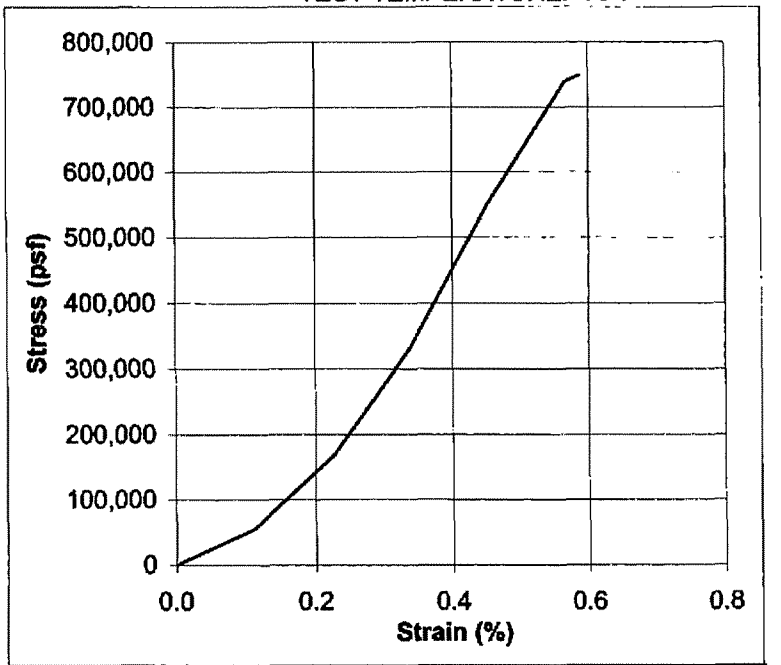


WATER CONTENT AFTER SHEAR	
CAN NUMBER	LP-7
WET WEIGHT + CAN (lbs.)	2.04
DRY WEIGHT + CAN (lbs.)	2.03
WEIGHT WATER (lbs.)	0.00
WEIGHT CAN (lbs.)	0.90
WEIGHT SOLID (lbs.)	1.13
MOISTURE (%)	**0.2**

PROVING RING NO.: QC200

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
5	1,050	1,050	0.1	55,766
10	3,150	3,150	0.2	167,298
15	6,295	6,295	0.3	334,331
20	10,375	10,375	0.5	551,022
25	13,900	13,900	0.6	738,237
26	14,100	14,100	0.6	748,859

TEST TEMPERATURE: 70°F



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**0.2**
STRAIN AT FAILURE (%)	**0.6**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**748.9**
SHEAR STRENGTH (ksf)	**374.4**

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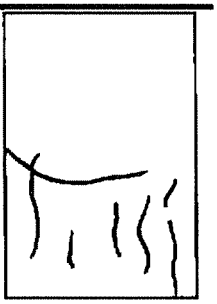
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 2 SAMPLE NUMBER: RC DEPTH (ft.): 30.8-31.3
SAMPLE DESCRIPTION: Gray trace brown moderately weathered shale
BEDROCK FORMATION: Fairview Formation DATE: 1/20/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.85
HEIGHT (in.)	4.36
HEIGHT TO DIAMETER RATIO	2.36
AVERAGE AREA (sq. ft.)	0.0187
VOLUME (cu. ft.)	0.0068
WET WEIGHT (lbs.)	0.99
DRY WEIGHT (lbs.)	0.89
DRY DENSITY (pcf)	**131.8**

FAILURE SHAPE

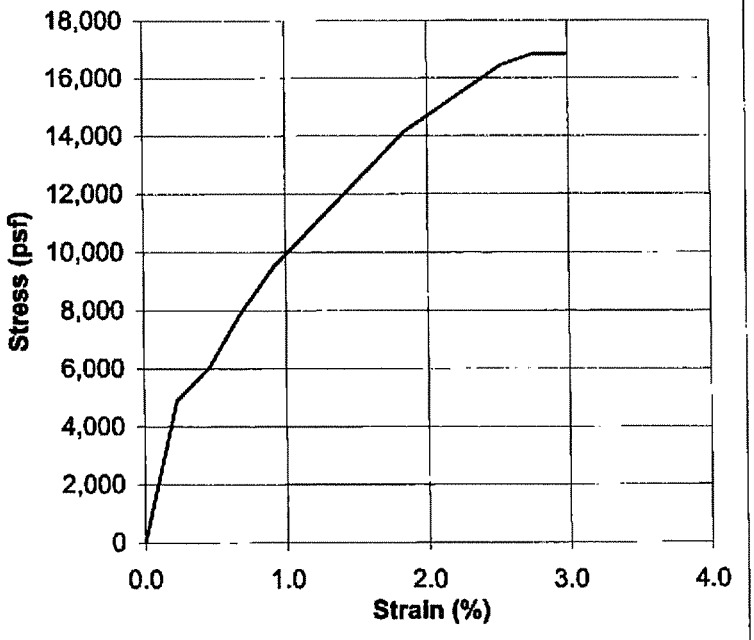


WATER CONTENT AFTER SHEAR	
CAN NUMBER	KP4
WET WEIGHT + CAN (lbs.)	1.92
DRY WEIGHT + CAN (lbs.)	1.82
WEIGHT WATER (lbs.)	0.10
WEIGHT CAN (lbs.)	0.93
WEIGHT SOLID (lbs.)	0.89
MOISTURE (%)	**11.0**

PROVING RING NO.: 19901

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
10	7	91	0.2	4,885
20	10	113	0.5	6,041
30	15	149	0.7	7,968
40	19	178	0.9	9,509
50	22	199	1.1	10,665
60	25	221	1.4	11,822
70	28	242	1.6	12,978
80	31	264	1.8	14,134
90	33	278	2.1	14,905
100	35	293	2.3	15,676
110	37	307	2.5	16,446
120	38	314	2.8	16,832
130	38	314	3.0	16,832

TEST TEMPERATURE: 70°F



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**1.3**
STRAIN AT FAILURE (%)	**2.8**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**16.8**
SHEAR STRENGTH (ksf)	**8.4**

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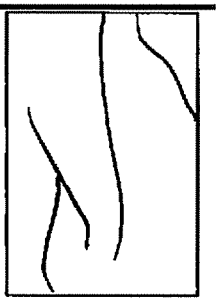
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 2 SAMPLE NUMBER: RC DEPTH (ft.): 34.1-34.6
SAMPLE DESCRIPTION: Gray unweathered limestone
BEDROCK FORMATION: Fairview Formation DATE: 1/20/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.86
HEIGHT (in.)	4.43
HEIGHT TO DIAMETER RATIO	2.39
AVERAGE AREA (sq. ft.)	0.0188
VOLUME (cu. ft.)	0.0069
WET WEIGHT (lbs.)	1.13
DRY WEIGHT (lbs.)	1.13
DRY DENSITY (pcf)	**162.7**

FAILURE SHAPE

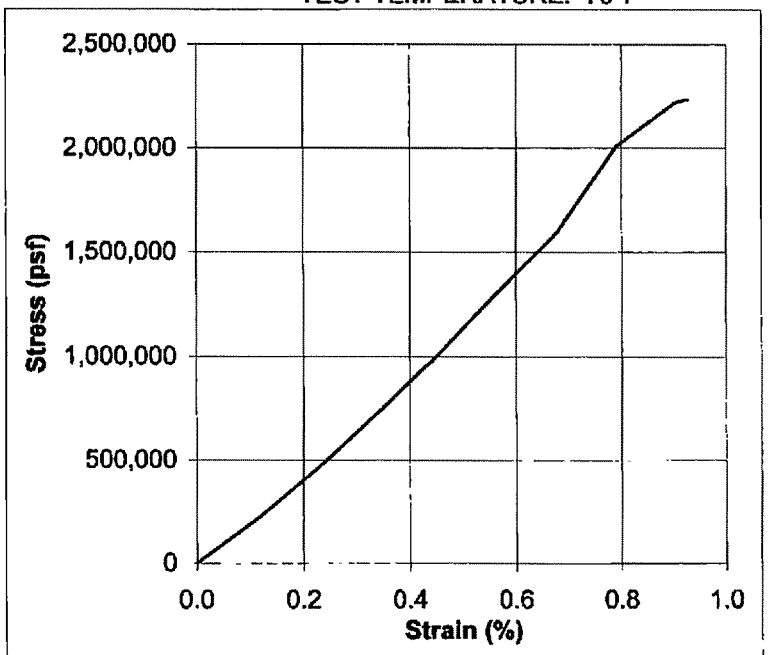


WATER CONTENT AFTER SHEAR	
CAN NUMBER	A12
WET WEIGHT + CAN (lbs.)	1.91
DRY WEIGHT + CAN (lbs.)	1.90
WEIGHT WATER (lbs.)	0.00
WEIGHT CAN (lbs.)	0.91
WEIGHT SOLID (lbs.)	0.99
MOISTURE (%)	**0.3**

PROVING RING NO.: QC200

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
5	3,985	3,985	0.1	212,102
10	8,595	8,595	0.2	457,470
15	13,700	13,700	0.3	729,184
20	18,900	18,900	0.5	1,005,955
25	24,610	24,610	0.6	1,309,870
30	29,920	29,920	0.7	1,592,496
35	37,715	37,715	0.8	2,007,385
40	41,705	41,705	0.9	2,219,754
41	41,950	41,950	0.9	2,232,794

TEST TEMPERATURE: 70°F



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**0.2**
STRAIN AT FAILURE (%)	**0.9**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**2,232.8**
SHEAR STRENGTH (ksf)	**1116.4**

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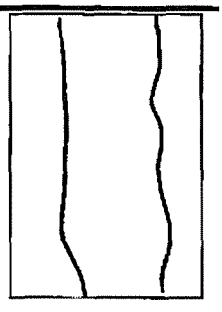
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 3 SAMPLE NUMBER: RC DEPTH (ft.): 23.3-23.7
SAMPLE DESCRIPTION: Gray unweathered limestone
BEDROCK FORMATION: Fairview Formation DATE: 1/20/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.86
HEIGHT (in.)	4.10
HEIGHT TO DIAMETER RATIO	2.20
AVERAGE AREA (sq. ft.)	0.0188
VOLUME (cu. ft.)	0.0064
WET WEIGHT (lbs.)	1.08
DRY WEIGHT (lbs.)	1.08
DRY DENSITY (pcf)	**168.2**

FAILURE SHAPE

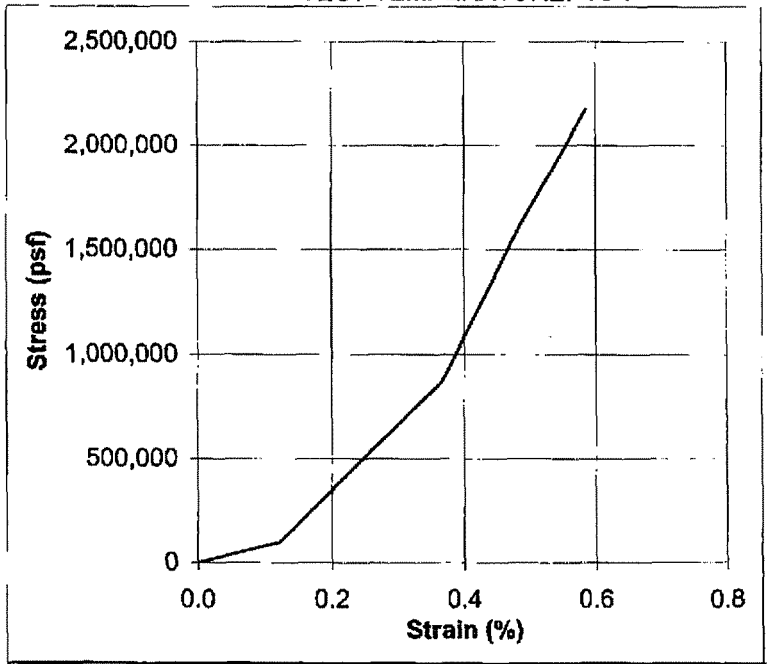


WATER CONTENT AFTER SHEAR	
CAN NUMBER	T10
WET WEIGHT + CAN (lbs.)	1.89
DRY WEIGHT + CAN (lbs.)	1.89
WEIGHT WATER (lbs.)	0.00
WEIGHT CAN (lbs.)	0.90
WEIGHT SOLID (lbs.)	0.99
MOISTURE (%)	**0.1**

PROVING RING NO.: QC200

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
5	1,830	1,830	0.1	97,088
10	9,250	9,250	0.2	490,745
15	16,355	16,355	0.4	867,690
20	30,715	30,715	0.5	1,629,537
24	41,030	41,030	0.6	2,176,784

TEST TEMPERATURE: 70°F



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**0.2**
STRAIN AT FAILURE (%)	**0.6**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**2,176.8**
SHEAR STRENGTH (ksf)	**1088.4**

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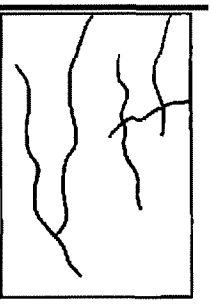
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 3 SAMPLE NUMBER: RC DEPTH (ft.): 29.6-30.2
SAMPLE DESCRIPTION: Gray trace brown moderately weatherd shale
BEDROCK FORMATION: Fairview Formation DATE: 1/20/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.83
HEIGHT (in.)	4.44
HEIGHT TO DIAMETER RATIO	2.43
AVERAGE AREA (sq. ft.)	0.0182
VOLUME (cu. ft.)	0.0067
WET WEIGHT (lbs.)	0.99
DRY WEIGHT (lbs.)	0.90
DRY DENSITY (pcf)	**133.5**

FAILURE SHAPE

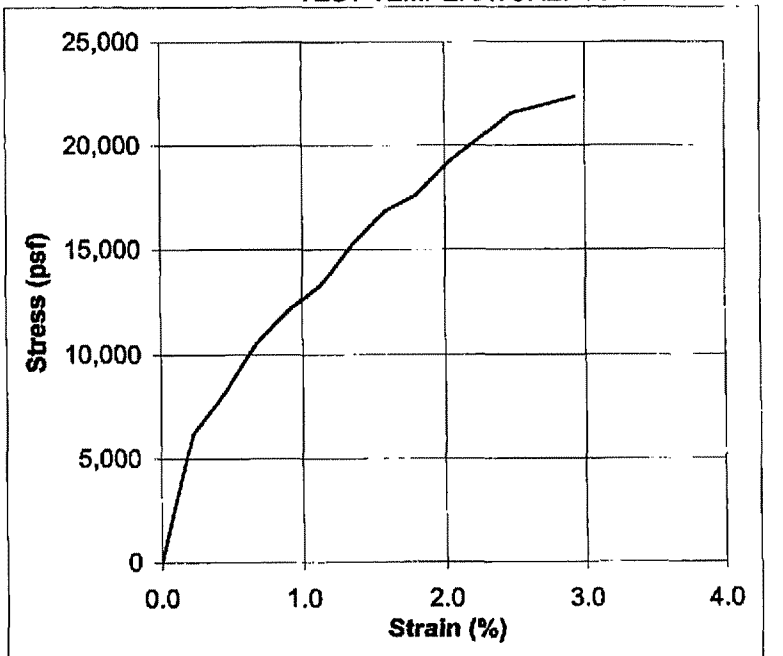


WATER CONTENT AFTER SHEAR	
CAN NUMBER	KP10
WET WEIGHT + CAN (lbs.)	1.89
DRY WEIGHT + CAN (lbs.)	1.81
WEIGHT WATER (lbs.)	0.09
WEIGHT CAN (lbs.)	0.92
WEIGHT SOLID (lbs.)	0.89
MOISTURE (%)	**9.9**

PROVING RING NO.: 19901

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
10	10	113	0.2	6,180
20	15	149	0.5	8,152
30	21	192	0.7	10,518
40	25	221	0.9	12,095
50	28	242	1.1	13,278
60	33	278	1.4	15,249
70	37	307	1.6	16,826
80	39	321	1.8	17,615
90	43	350	2.0	19,192
100	46	372	2.3	20,375
110	49	393	2.5	21,558
120	50	401	2.7	21,952
130	51	408	2.9	22,346

TEST TEMPERATURE: 70°F



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**1.2**
STRAIN AT FAILURE (%)	**2.9**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**22.3**
SHEAR STRENGTH (ksf)	**11.2**

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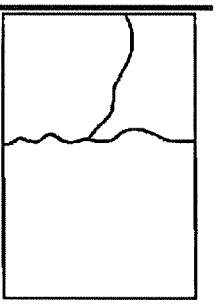
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 3 SAMPLE NUMBER: RC DEPTH (ft.): 35.8-36.3
SAMPLE DESCRIPTION: Gray and brown slightly weathered fossiliferous limestone
BEDROCK FORMATION: Fairview Formation DATE: 1/20/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.86
HEIGHT (in.)	4.45
HEIGHT TO DIAMETER RATIO	2.39
AVERAGE AREA (sq. ft.)	0.0189
VOLUME (cu. ft.)	0.0070
WET WEIGHT (lbs.)	1.16
DRY WEIGHT (lbs.)	1.16
DRY DENSITY (pcf)	**165.2**

FAILURE SHAPE

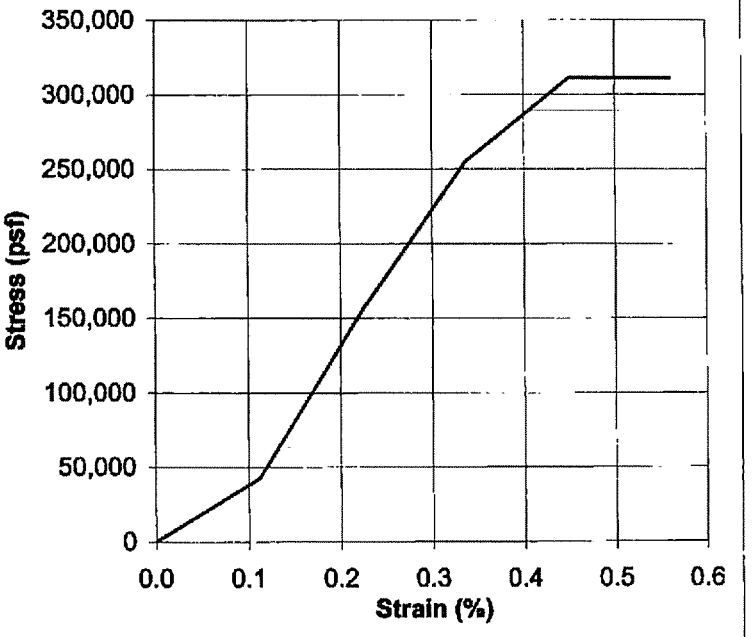


WATER CONTENT AFTER SHEAR	
CAN NUMBER	E11
WET WEIGHT + CAN (lbs.)	2.10
DRY WEIGHT + CAN (lbs.)	2.09
WEIGHT WATER (lbs.)	0.01
WEIGHT CAN (lbs.)	0.94
WEIGHT SOLID (lbs.)	1.15
MOISTURE (%)	**0.7**

PROVING RING NO.: QC200

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
5	805	805	0.1	42,662
10	2,945	2,945	0.2	156,075
15	4,815	4,815	0.3	255,178
20	5,865	5,865	0.4	310,824
25	5,865	5,865	0.6	310,824

TEST TEMPERATURE: 70°F



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**0.2**
STRAIN AT FAILURE (%)	**0.4**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**310.8**
SHEAR STRENGTH (ksf)	**155.4**

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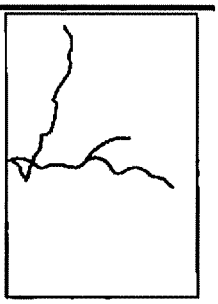
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 3 SAMPLE NUMBER: RC DEPTH (ft.): 48.0-48.4
SAMPLE DESCRIPTION: Gray unweathered shale
BEDROCK FORMATION: Fairview Formation DATE: 1/20/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.70
HEIGHT (in.)	4.16
HEIGHT TO DIAMETER RATIO	2.46
AVERAGE AREA (sq. ft.)	0.0157
VOLUME (cu. ft.)	0.0054
WET WEIGHT (lbs.)	0.91
DRY WEIGHT (lbs.)	0.86
DRY DENSITY (pcf)	**158.9**

FAILURE SHAPE

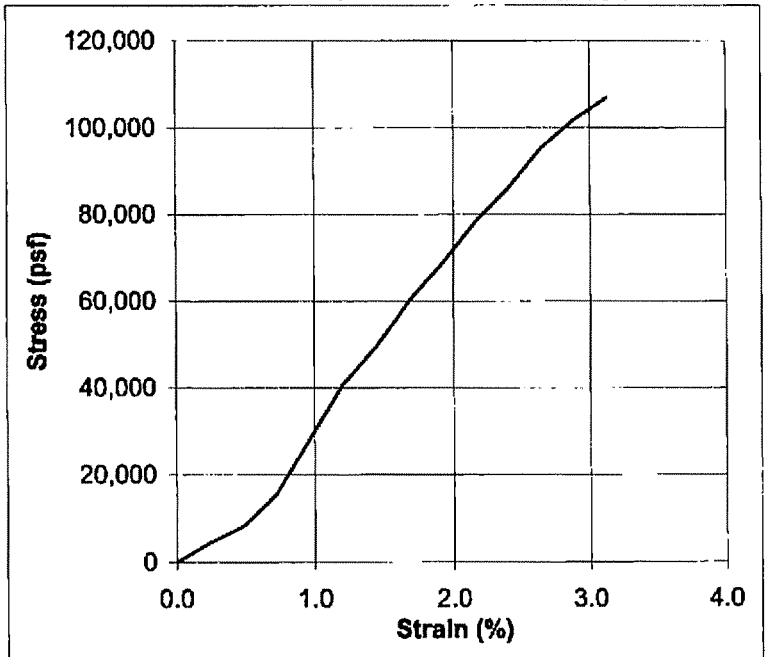


WATER CONTENT AFTER SHEAR	
CAN NUMBER	A10
WET WEIGHT + CAN (lbs.)	1.80
DRY WEIGHT + CAN (lbs.)	1.76
WEIGHT WATER (lbs.)	0.04
WEIGHT CAN (lbs.)	0.90
WEIGHT SOLID (lbs.)	0.86
MOISTURE (%)	**4.8**

PROVING RING NO.: 19901

TEST TEMPERATURE: 70°F

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
10	4	70	0.2	4,442
20	12	127	0.5	8,114
30	28	242	0.7	15,460
40	55	436	1.0	27,856
50	83	638	1.2	40,710
60	102	775	1.4	49,433
70	125	940	1.7	59,992
80	144	1,077	1.9	68,715
90	165	1,228	2.2	78,356
100	182	1,350	2.4	86,161
110	202	1,494	2.6	95,343
120	216	1,595	2.9	101,770
130	227	1,674	3.1	106,820



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**0.8**
STRAIN AT FAILURE (%)	**3.1**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**106.8**
SHEAR STRENGTH (ksf)	**53.4**

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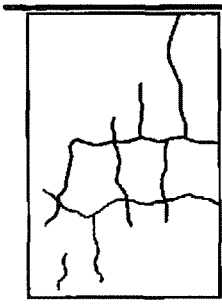
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 3 SAMPLE NUMBER: RC DEPTH (ft.): 52.0-52.3
SAMPLE DESCRIPTION: Gray trace brown slightly weathered shale
BEDROCK FORMATION: Fairview Formation DATE: 1/23/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.85
HEIGHT (in.)	3.09
HEIGHT TO DIAMETER RATIO	1.67
AVERAGE AREA (sq. ft.)	0.0187
VOLUME (cu. ft.)	0.0048
WET WEIGHT (lbs.)	0.72
DRY WEIGHT (lbs.)	0.66
DRY DENSITY (pcf)	**136.2**

FAILURE SHAPE

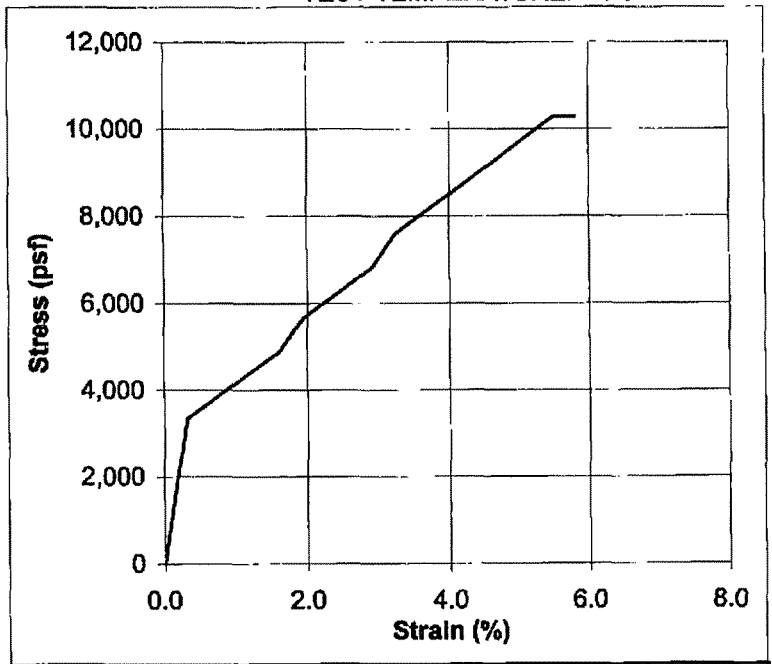


WATER CONTENT AFTER SHEAR	
CAN NUMBER	KP3
WET WEIGHT + CAN (lbs.)	1.65
DRY WEIGHT + CAN (lbs.)	1.59
WEIGHT WATER (lbs.)	0.07
WEIGHT CAN (lbs.)	0.93
WEIGHT SOLID (lbs.)	0.65
MOISTURE (%)	**10.1**

PROVING RING NO.: 19901

TEST TEMPERATURE: 70°F

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
10	3	62	0.3	3,343
20	4	70	0.6	3,728
30	5	77	1.0	4,114
40	6	84	1.3	4,499
50	7	91	1.6	4,885
60	9	106	1.9	5,655
70	10	113	2.3	6,041
80	11	120	2.6	6,426
90	12	127	2.9	6,812
100	14	142	3.2	7,582
110	15	149	3.6	7,968
120	16	156	3.9	8,353
130	17	163	4.2	8,739
140	18	170	4.5	9,124
150	19	178	4.8	9,509
160	20	185	5.2	9,895
170	21	192	5.5	10,280
180	21	192	5.8	10,280



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**2.3**
STRAIN AT FAILURE (%)	**5.5**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**10.3**
SHEAR STRENGTH (ksf)	**5.1**

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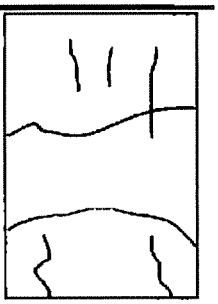
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 5 SAMPLE NUMBER: RC DEPTH (ft.): 13.4-14.3
SAMPLE DESCRIPTION: Brown trace gray moderately weathered shale
BEDROCK FORMATION: Fairview Formation DATE: 1/23/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.80
HEIGHT (in.)	4.25
HEIGHT TO DIAMETER RATIO	2.36
AVERAGE AREA (sq. ft.)	0.0177
VOLUME (cu. ft.)	0.0063
WET WEIGHT (lbs.)	0.91
DRY WEIGHT (lbs.)	0.80
DRY DENSITY (pcf)	**127.1**

FAILURE SHAPE

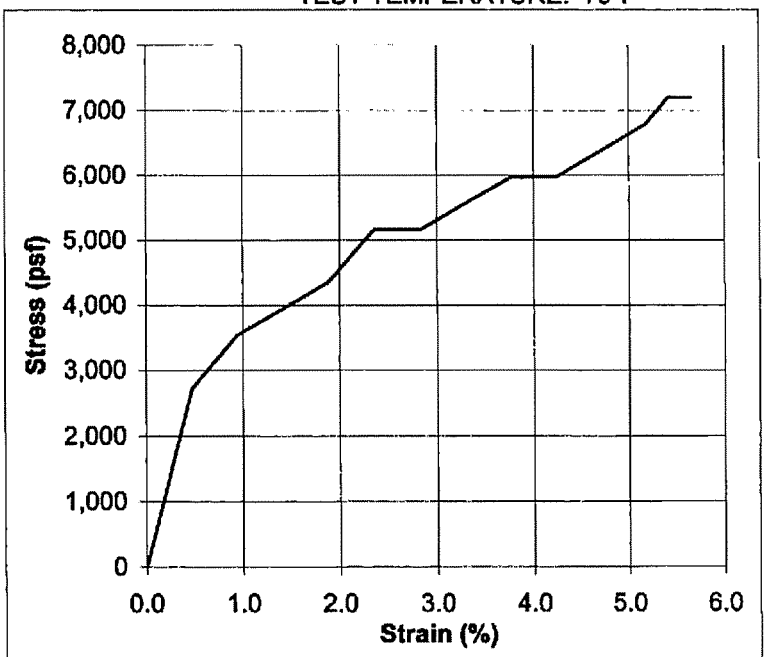


WATER CONTENT AFTER SHEAR	
CAN NUMBER	t25
WET WEIGHT + CAN (lbs.)	1.80
DRY WEIGHT + CAN (lbs.)	1.69
WEIGHT WATER (lbs.)	0.11
WEIGHT CAN (lbs.)	0.90
WEIGHT SOLID (lbs.)	0.79
MOISTURE (%)	**14.4**

PROVING RING NO.: 19901

TEST TEMPERATURE: 70°F

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
20	1	48	0.5	2,717
40	3	62	0.9	3,531
60	4	70	1.4	3,938
80	5	77	1.9	4,346
100	7	91	2.4	5,160
120	7	91	2.8	5,160
140	8	98	3.3	5,567
160	9	106	3.8	5,974
180	9	106	4.2	5,974
200	10	113	4.7	6,381
220	11	120	5.2	6,788
230	12	127	5.4	7,195
240	12	127	5.7	7,195



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**1.4**
STRAIN AT FAILURE (%)	**5.4**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**7.2**
SHEAR STRENGTH (ksf)	**3.6**

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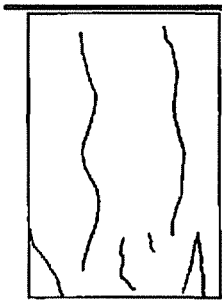
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 5 SAMPLE NUMBER: RC DEPTH (ft.): 16.2-16.7
SAMPLE DESCRIPTION: Gray trace brown slightly weathered limestone
BEDROCK FORMATION: Fairview Formation DATE: 2/2/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.85
HEIGHT (in.)	4.29
HEIGHT TO DIAMETER RATIO	2.31
AVERAGE AREA (sq. ft.)	0.0187
VOLUME (cu. ft.)	0.0067
WET WEIGHT (lbs.)	1.13
DRY WEIGHT (lbs.)	1.13
DRY DENSITY (pcf)	**168.4**

FAILURE SHAPE

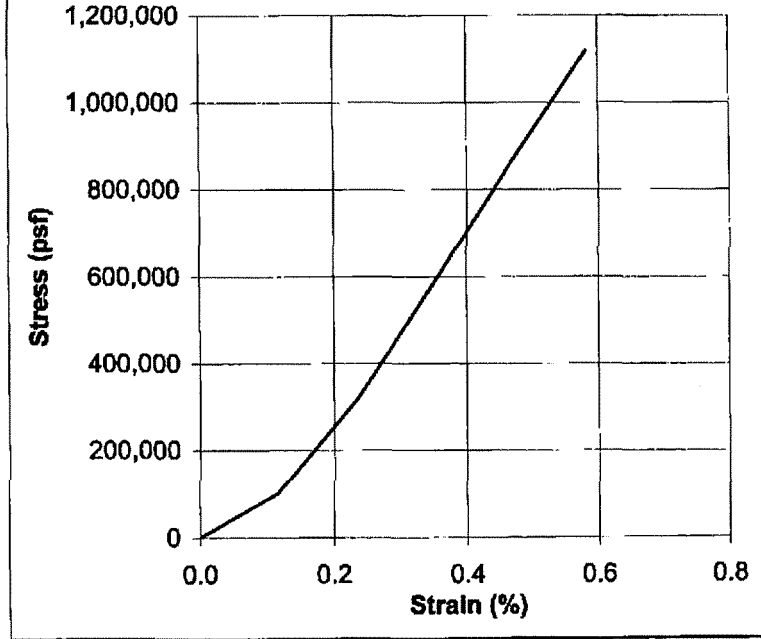


WATER CONTENT AFTER SHEAR	
CAN NUMBER	t8
WET WEIGHT + CAN (lbs.)	2.01
DRY WEIGHT + CAN (lbs.)	2.01
WEIGHT WATER (lbs.)	0.00
WEIGHT CAN (lbs.)	0.90
WEIGHT SOLID (lbs.)	1.11
MOISTURE (%)	**0.2**

PROVING RING NO.: QC200

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
5	1,890	1,890	0.1	100,813
10	5,905	5,905	0.2	314,973
15	10,925	10,925	0.3	582,740
20	16,145	16,145	0.5	861,175
25	20,990	20,990	0.6	1,119,607

TEST TEMPERATURE: 70°F



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**0.2**
STRAIN AT FAILURE (%)	**0.6**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**1,119.6**
SHEAR STRENGTH (ksf)	**559.8**

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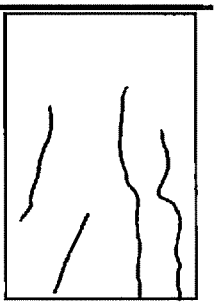
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 5 SAMPLE NUMBER: RC DEPTH (ft.): 31.6-32.1
SAMPLE DESCRIPTION: Gray and brown moderately weathered shale
BEDROCK FORMATION: Fairview Formation DATE: 1/23/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.85
HEIGHT (in.)	4.28
HEIGHT TO DIAMETER RATIO	2.32
AVERAGE AREA (sq. ft.)	0.0186
VOLUME (cu. ft.)	0.0066
WET WEIGHT (lbs.)	0.96
DRY WEIGHT (lbs.)	0.85
DRY DENSITY (pcf)	**128.3**

FAILURE SHAPE

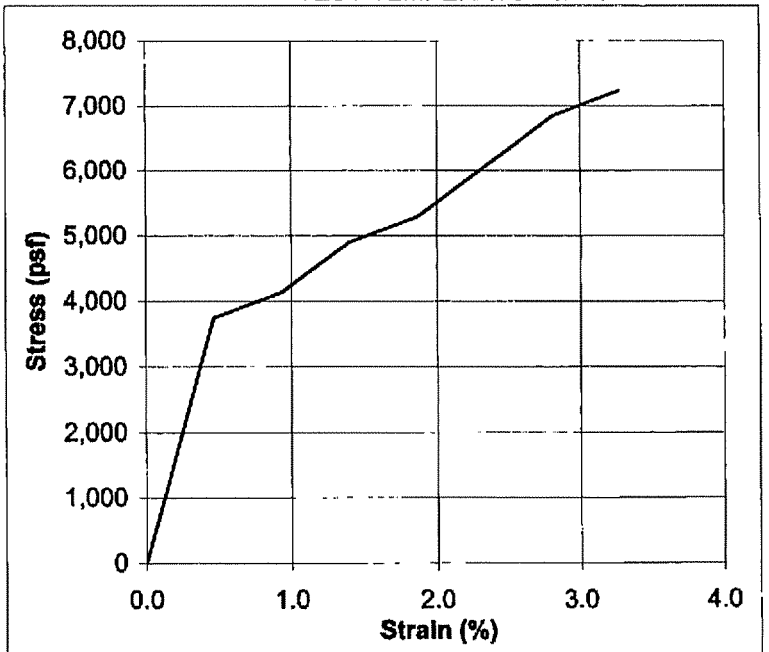


WATER CONTENT AFTER SHEAR	
CAN NUMBER	t6
WET WEIGHT + CAN (lbs.)	1.87
DRY WEIGHT + CAN (lbs.)	1.76
WEIGHT WATER (lbs.)	0.11
WEIGHT CAN (lbs.)	0.91
WEIGHT SOLID (lbs.)	0.85
MOISTURE (%)	**13.2**

PROVING RING NO.: 19901

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
20	4	70	0.5	3,745
40	5	77	0.9	4,132
60	7	91	1.4	4,906
80	8	98	1.9	5,293
100	10	113	2.3	6,067
120	12	127	2.8	6,841
140	13	134	3.3	7,228

TEST TEMPERATURE: 70°F



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**1.6**
STRAIN AT FAILURE (%)	**3.3**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**7.2**
SHEAR STRENGTH (ksf)	**3.6**

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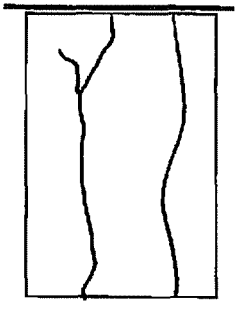
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 5 SAMPLE NUMBER: RC DEPTH (ft.): 34.2-34.7
SAMPLE DESCRIPTION: Gray trace brown slightly weathered limestone
BEDROCK FORMATION: Fairview Formation DATE: 1/27/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.86
HEIGHT (in.)	4.28
HEIGHT TO DIAMETER RATIO	2.30
AVERAGE AREA (sq. ft.)	0.0189
VOLUME (cu. ft.)	0.0067
WET WEIGHT (lbs.)	1.12
DRY WEIGHT (lbs.)	1.12
DRY DENSITY (pcf)	**166.3**

FAILURE SHAPE

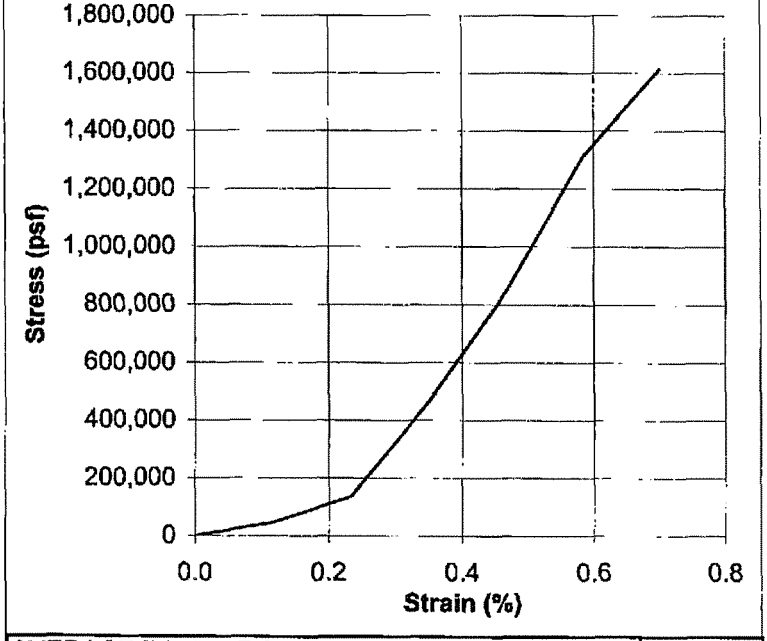


WATER CONTENT AFTER SHEAR	
CAN NUMBER	A2
WET WEIGHT + CAN (lbs.)	1.96
DRY WEIGHT + CAN (lbs.)	1.96
WEIGHT WATER (lbs.)	0.00
WEIGHT CAN (lbs.)	0.91
WEIGHT SOLID (lbs.)	1.05
MOISTURE (%)	**0.3**

PROVING RING NO.: QC200

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
5	870	870	0.1	46,107
10	2,570	2,570	0.2	136,201
15	8,795	8,795	0.4	466,104
20	16,005	16,005	0.5	848,208
25	24,750	24,750	0.6	1,311,662
30	30,435	30,435	0.7	1,612,947

TEST TEMPERATURE: 70°F



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**0.2**
STRAIN AT FAILURE (%)	**0.7**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**1,612.9**
SHEAR STRENGTH (ksf)	**806.5**

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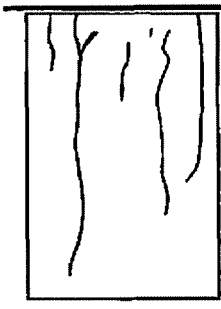
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 5 SAMPLE NUMBER: RC DEPTH (ft.): 40.7-41.2
SAMPLE DESCRIPTION: Gray unweathered shale
BEDROCK FORMATION: Fairview Formation DATE: 1/23/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.85
HEIGHT (in.)	4.30
HEIGHT TO DIAMETER RATIO	2.32
AVERAGE AREA (sq. ft.)	0.0187
VOLUME (cu. ft.)	0.0067
WET WEIGHT (lbs.)	1.02
DRY WEIGHT (lbs.)	0.95
DRY DENSITY (pcf)	**142.0**

FAILURE SHAPE

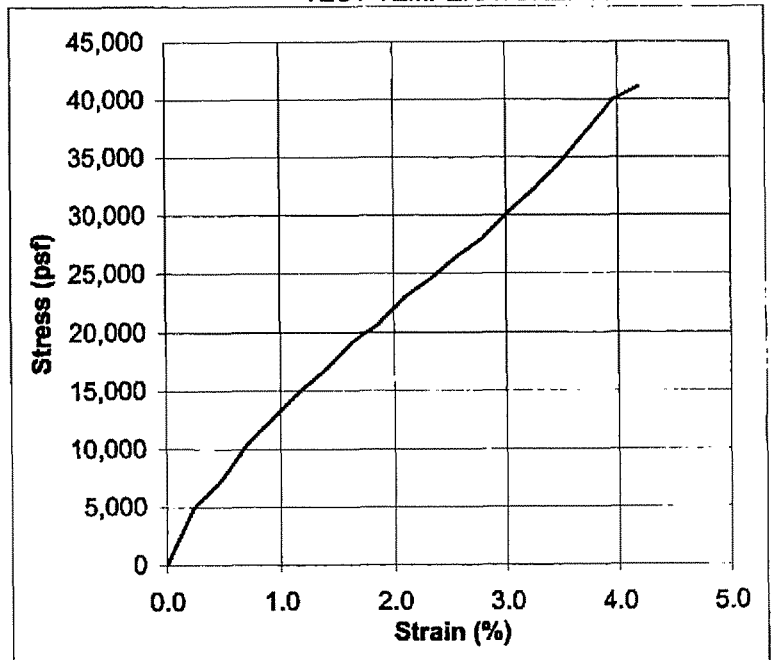


WATER CONTENT AFTER SHEAR	
CAN NUMBER	g8
WET WEIGHT + CAN (lbs.)	1.91
DRY WEIGHT + CAN (lbs.)	1.84
WEIGHT WATER (lbs.)	0.07
WEIGHT CAN (lbs.)	0.89
WEIGHT SOLID (lbs.)	0.94
MOISTURE (%)	**7.7**

PROVING RING NO.: 19901

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
10	7	91	0.2	4,885
20	13	134	0.5	7,197
30	21	192	0.7	10,280
40	27	235	0.9	12,592
50	33	278	1.2	14,905
60	38	314	1.4	16,832
70	44	357	1.6	19,144
80	48	386	1.9	20,686
90	54	429	2.1	22,998
100	58	458	2.3	24,540
110	63	494	2.6	26,466
120	67	523	2.8	28,008
130	73	566	3.0	30,320
140	78	602	3.3	32,247
150	84	645	3.5	34,560
160	91	695	3.7	37,257
170	98	746	4.0	39,955
180	101	767	4.2	41,111

TEST TEMPERATURE: 70°F



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**1.4**
STRAIN AT FAILURE (%)	**4.2**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**41.1**
SHEAR STRENGTH (ksf)	**20.6**

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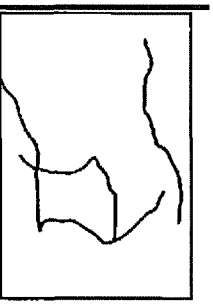
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 5 SAMPLE NUMBER: RC DEPTH (ft.): 44.7-45.2
SAMPLE DESCRIPTION: Gray trace brown slightly weathered shale
BEDROCK FORMATION: Fairview Formation DATE: 1/23/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.83
HEIGHT (in.)	4.36
HEIGHT TO DIAMETER RATIO	2.38
AVERAGE AREA (sq. ft.)	0.0183
VOLUME (cu. ft.)	0.0066
WET WEIGHT (lbs.)	0.99
DRY WEIGHT (lbs.)	0.91
DRY DENSITY (pcf)	**136.8**

FAILURE SHAPE

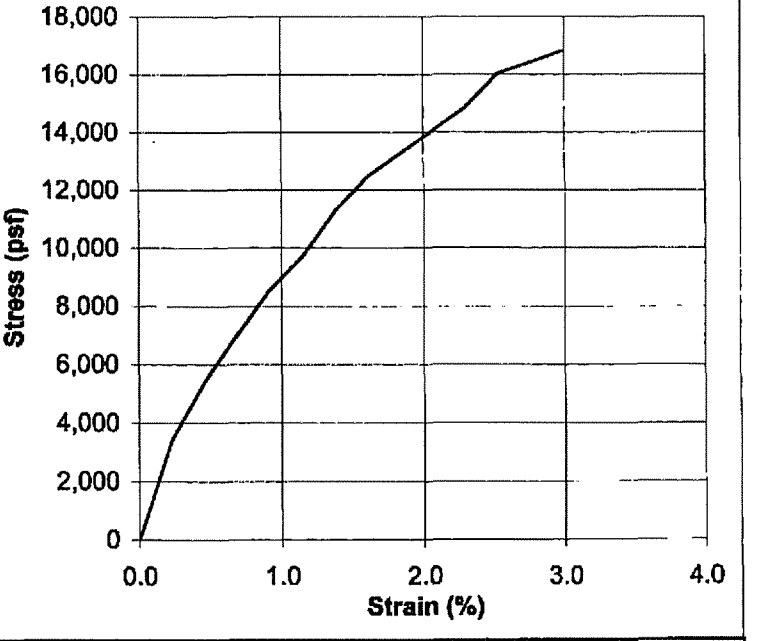


WATER CONTENT AFTER SHEAR	
CAN NUMBER	t8
WET WEIGHT + CAN (lbs.)	1.89
DRY WEIGHT + CAN (lbs.)	1.81
WEIGHT WATER (lbs.)	0.09
WEIGHT CAN (lbs.)	0.90
WEIGHT SOLID (lbs.)	0.91
MOISTURE (%)	**9.5**

PROVING RING NO.: 19901

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
10	3	62	0.2	3,417
20	8	98	0.5	5,386
30	12	127	0.7	6,961
40	16	156	0.9	8,537
50	19	178	1.1	9,718
60	23	206	1.4	11,294
70	26	228	1.6	12,475
80	28	242	1.8	13,263
90	30	257	2.1	14,051
100	32	271	2.3	14,838
110	35	293	2.5	16,020
120	36	300	2.8	16,414
130	37	307	3.0	16,808

TEST TEMPERATURE: 70°F



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**1.5**
STRAIN AT FAILURE (%)	**3.0**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**16.8**
SHEAR STRENGTH (ksf)	**8.4**

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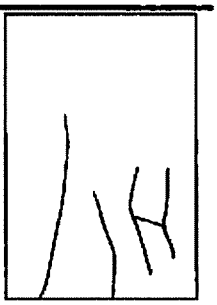
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 5 SAMPLE NUMBER: RC DEPTH (ft.): 46.1-46.5
SAMPLE DESCRIPTION: Gray slightly weahtered shale
BEDROCK FORMATION: Fairview Formation DATE: 1/23/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.84
HEIGHT (in.)	4.24
HEIGHT TO DIAMETER RATIO	2.30
AVERAGE AREA (sq. ft.)	0.0185
VOLUME (cu. ft.)	0.0065
WET WEIGHT (lbs.)	0.98
DRY WEIGHT (lbs.)	0.94
DRY DENSITY (pcf)	**144.2**

FAILURE SHAPE

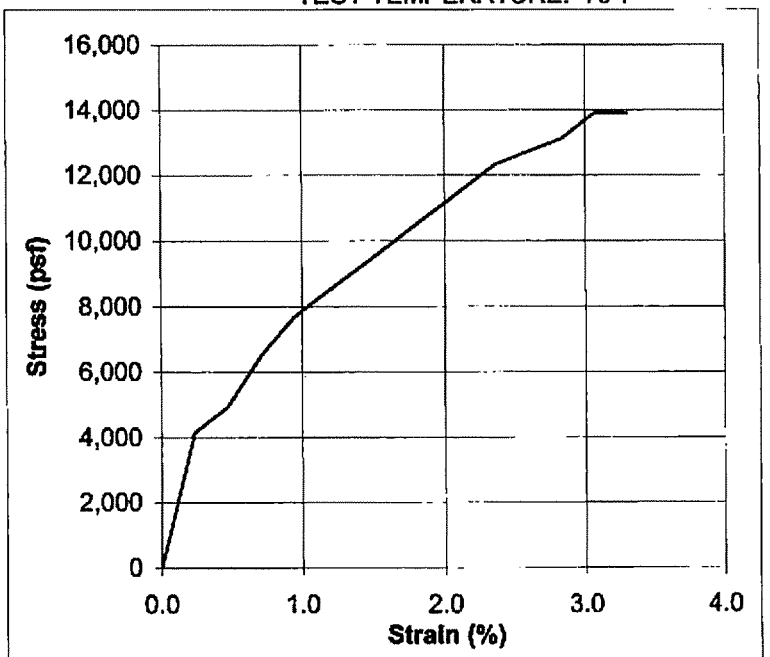


WATER CONTENT AFTER SHEAR	
CAN NUMBER	t28
WET WEIGHT + CAN (lbs.)	1.84
DRY WEIGHT + CAN (lbs.)	1.80
WEIGHT WATER (lbs.)	0.04
WEIGHT CAN (lbs.)	0.90
WEIGHT SOLID (lbs.)	0.90
MOISTURE (%)	**4.8**

PROVING RING NO.: 19901

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
10	5	77	0.2	4,159
20	7	91	0.5	4,938
30	11	120	0.7	6,496
40	14	142	0.9	7,665
50	16	156	1.2	8,444
60	18	170	1.4	9,223
70	20	185	1.7	10,003
80	22	199	1.9	10,782
90	24	213	2.1	11,561
100	26	228	2.4	12,340
110	27	235	2.6	12,730
120	28	242	2.8	13,119
130	30	257	3.1	13,898
140	30	257	3.3	13,898

TEST TEMPERATURE: 70°F



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**1.1**
STRAIN AT FAILURE (%)	**3.1**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**13.9**
SHEAR STRENGTH (ksf)	**6.9**

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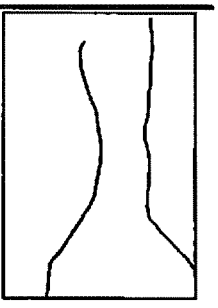
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 6 SAMPLE NUMBER: RC DEPTH (ft.): 54.3-54.7
SAMPLE DESCRIPTION: Gray unweathered limestone
BEDROCK FORMATION: Fairview Formation DATE: 1/27/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.86
HEIGHT (in.)	4.17
HEIGHT TO DIAMETER RATIO	2.24
AVERAGE AREA (sq. ft.)	0.0189
VOLUME (cu. ft.)	0.0066
WET WEIGHT (lbs.)	1.11
DRY WEIGHT (lbs.)	1.10
DRY DENSITY (pcf)	**168.4**

FAILURE SHAPE

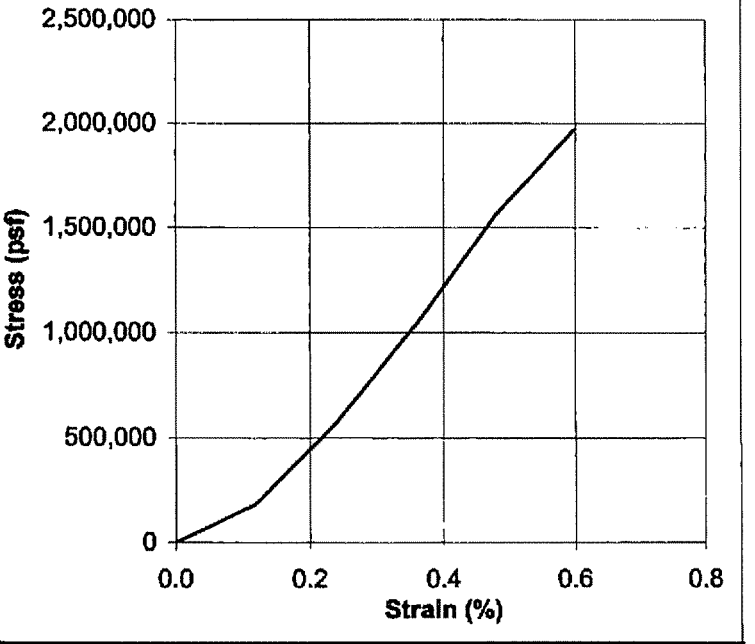


WATER CONTENT AFTER SHEAR	
CAN NUMBER	t6
WET WEIGHT + CAN (lbs.)	1.94
DRY WEIGHT + CAN (lbs.)	1.94
WEIGHT WATER (lbs.)	0.00
WEIGHT CAN (lbs.)	0.91
WEIGHT SOLID (lbs.)	1.03
MOISTURE (%)	**0.1**

PROVING RING NO.: QC200

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
5	3,455	3,455	0.1	183,103
10	10,785	10,785	0.2	571,567
15	19,640	19,640	0.4	1,040,850
20	29,460	29,460	0.5	1,561,275
25	37,225	37,225	0.6	1,972,793

TEST TEMPERATURE: 70°F



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**0.1**
STRAIN AT FAILURE (%)	**0.6**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**1,972.8**
SHEAR STRENGTH (ksf)	**986.4**

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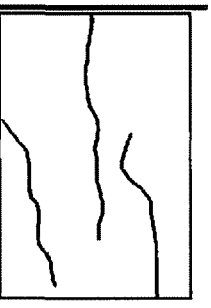
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 6 SAMPLE NUMBER: RC DEPTH (ft.): 55.5-56.0
SAMPLE DESCRIPTION: Gray unweathered shale
BEDROCK FORMATION: Fairview Formation DATE: 1/23/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.84
HEIGHT (in.)	4.29
HEIGHT TO DIAMETER RATIO	2.32
AVERAGE AREA (sq. ft.)	0.0185
VOLUME (cu. ft.)	0.0066
WET WEIGHT (lbs.)	1.03
DRY WEIGHT (lbs.)	0.97
DRY DENSITY (pcf)	**146.4**

FAILURE SHAPE

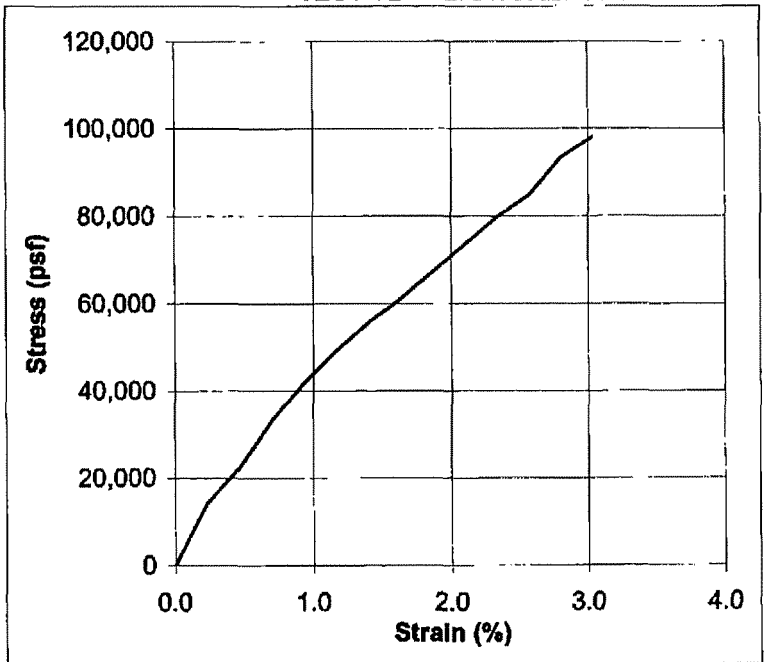


WATER CONTENT AFTER SHEAR	
CAN NUMBER	a13
WET WEIGHT + CAN (lbs.)	1.89
DRY WEIGHT + CAN (lbs.)	1.83
WEIGHT WATER (lbs.)	0.06
WEIGHT CAN (lbs.)	0.89
WEIGHT SOLID (lbs.)	0.94
MOISTURE (%)	**6.3**

PROVING RING NO.: 19901

TEST TEMPERATURE: 70°F

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
10	31	264	0.2	14,226
20	52	415	0.5	22,372
30	80	616	0.7	33,233
40	102	775	0.9	41,767
50	121	911	1.2	49,137
60	138	1,034	1.4	55,732
70	152	1,134	1.6	61,162
80	168	1,249	1.9	67,369
90	184	1,365	2.1	73,575
100	200	1,480	2.3	79,782
110	213	1,573	2.6	84,824
120	235	1,731	2.8	93,358
130	247	1,818	3.0	98,013



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**0.7**
STRAIN AT FAILURE (%)	**3.0**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**98.0**
SHEAR STRENGTH (ksf)	**49.0**

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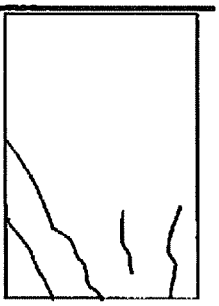
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 8 SAMPLE NUMBER: RC DEPTH (ft.): 24.2-24.9
SAMPLE DESCRIPTION: Gray trace brown slightly weathered shale
BEDROCK FORMATION: Fairview Formation DATE: 1/23/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.84
HEIGHT (in.)	4.41
HEIGHT TO DIAMETER RATIO	2.39
AVERAGE AREA (sq. ft.)	0.0185
VOLUME (cu. ft.)	0.0068
WET WEIGHT (lbs.)	1.05
DRY WEIGHT (lbs.)	0.98
DRY DENSITY (pcf)	**144.4**

FAILURE SHAPE

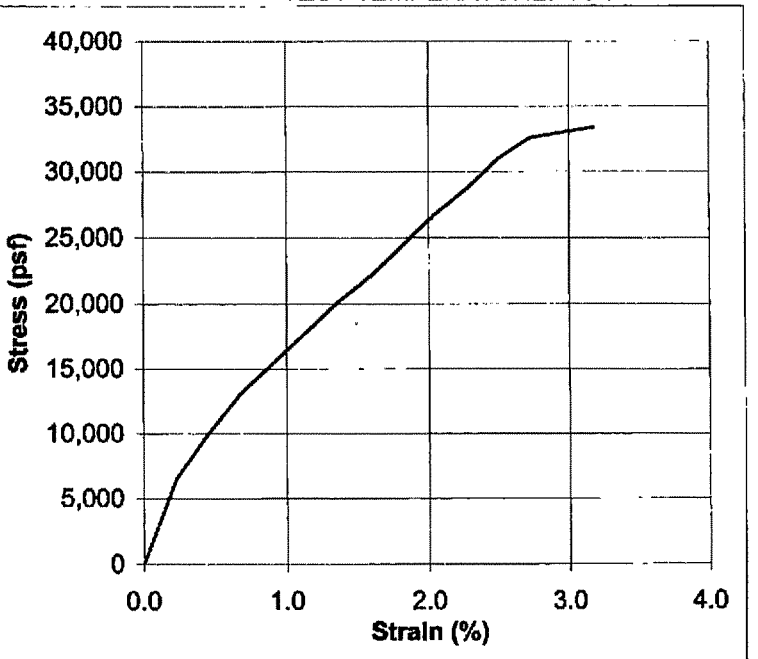


WATER CONTENT AFTER SHEAR	
CAN NUMBER	t24
WET WEIGHT + CAN (lbs.)	1.94
DRY WEIGHT + CAN (lbs.)	1.87
WEIGHT WATER (lbs.)	0.07
WEIGHT CAN (lbs.)	0.90
WEIGHT SOLID (lbs.)	0.97
MOISTURE (%)	**7.0**

PROVING RING NO.: 19901

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
10	11	120	0.2	6,496
20	20	185	0.5	10,003
30	28	242	0.7	13,119
40	34	285	0.9	15,457
50	40	329	1.1	17,794
60	46	372	1.4	20,132
70	51	408	1.6	22,080
80	57	451	1.8	24,417
90	63	494	2.0	26,755
100	68	530	2.3	28,703
110	74	573	2.5	31,040
120	78	602	2.7	32,599
130	79	609	3.0	32,988
140	80	616	3.2	33,378

TEST TEMPERATURE: 70°F



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**0.8**
STRAIN AT FAILURE (%)	**3.2**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**33.4**
SHEAR STRENGTH (ksf)	**16.7**

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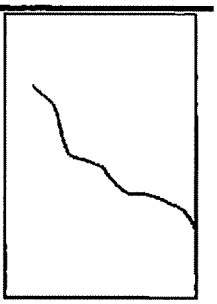
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 8 SAMPLE NUMBER: RC DEPTH (ft.): 26.5-27.0
SAMPLE DESCRIPTION: Gray trace brown slightly weathered limesotne
BEDROCK FORMATION: Fairview Formation DATE: 1/27/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.86
HEIGHT (in.)	4.23
HEIGHT TO DIAMETER RATIO	2.27
AVERAGE AREA (sq. ft.)	0.0189
VOLUME (cu. ft.)	0.0067
WET WEIGHT (lbs.)	1.13
DRY WEIGHT (lbs.)	1.12
DRY DENSITY (pcf)	**169.0**

FAILURE SHAPE

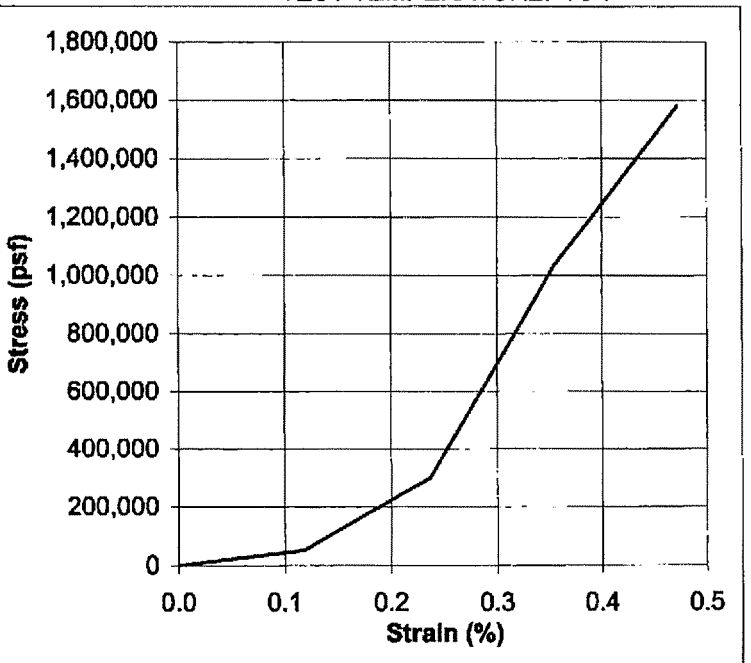


WATER CONTENT AFTER SHEAR	
CAN NUMBER	kp1
WET WEIGHT + CAN (lbs.)	1.91
DRY WEIGHT + CAN (lbs.)	1.91
WEIGHT WATER (lbs.)	0.00
WEIGHT CAN (lbs.)	0.93
WEIGHT SOLID (lbs.)	0.97
MOISTURE (%)	**0.2**

PROVING RING NO.: QC200

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
5	990	990	0.1	52,466
10	5,640	5,640	0.2	298,900
15	19,515	19,515	0.4	1,034,226
20	29,840	29,840	0.5	1,581,414

TEST TEMPERATURE: 70°F



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**0.2**
STRAIN AT FAILURE (%)	**0.5**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**1,581.4**
SHEAR STRENGTH (ksf)	**790.7**

REMARKS :

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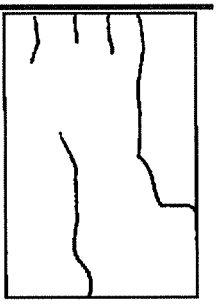
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 9 SAMPLE NUMBER: RC DEPTH (ft.): 13.6-14.0
SAMPLE DESCRIPTION: Gray slightly weathered shale
BEDROCK FORMATION: Fairview Formation DATE: 1/23/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.83
HEIGHT (in.)	4.14
HEIGHT TO DIAMETER RATIO	2.26
AVERAGE AREA (sq. ft.)	0.0183
VOLUME (cu. ft.)	0.0063
WET WEIGHT (lbs.)	0.95
DRY WEIGHT (lbs.)	0.88
DRY DENSITY (pcf)	**139.3**

FAILURE SHAPE

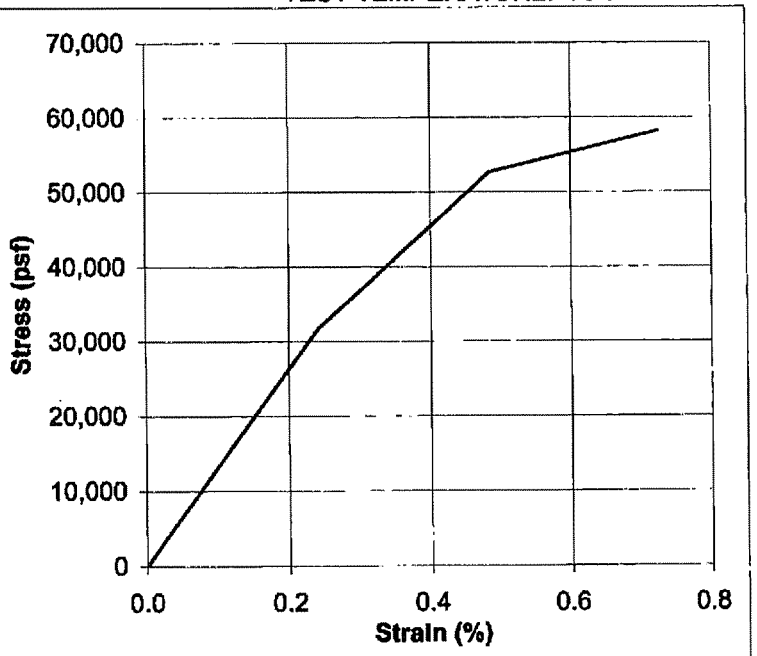


WATER CONTENT AFTER SHEAR	
CAN NUMBER	a2
WET WEIGHT + CAN (lbs.)	1.85
DRY WEIGHT + CAN (lbs.)	1.78
WEIGHT WATER (lbs.)	0.07
WEIGHT CAN (lbs.)	0.91
WEIGHT SOLID (lbs.)	0.87
MOISTURE (%)	**7.9**

PROVING RING NO.: 19901

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
10	75	580	0.2	31,774
20	128	962	0.5	52,649
30	142	1,062	0.7	58,163

TEST TEMPERATURE: 70°F



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**0.2**
STRAIN AT FAILURE (%)	**0.7**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**58.2**
SHEAR STRENGTH (ksf)	**29.1**

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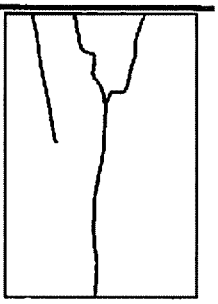
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 9 SAMPLE NUMBER: RC DEPTH (ft.): 25.2-25.6
SAMPLE DESCRIPTION: Gray trace brown slightly weathered limestone
BEDROCK FORMATION: Fairview Formation DATE: 1/27/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.86
HEIGHT (in.)	4.48
HEIGHT TO DIAMETER RATIO	2.41
AVERAGE AREA (sq. ft.)	0.0189
VOLUME (cu. ft.)	0.0070
WET WEIGHT (lbs.)	1.16
DRY WEIGHT (lbs.)	1.16
DRY DENSITY (pcf)	**164.1**

FAILURE SHAPE

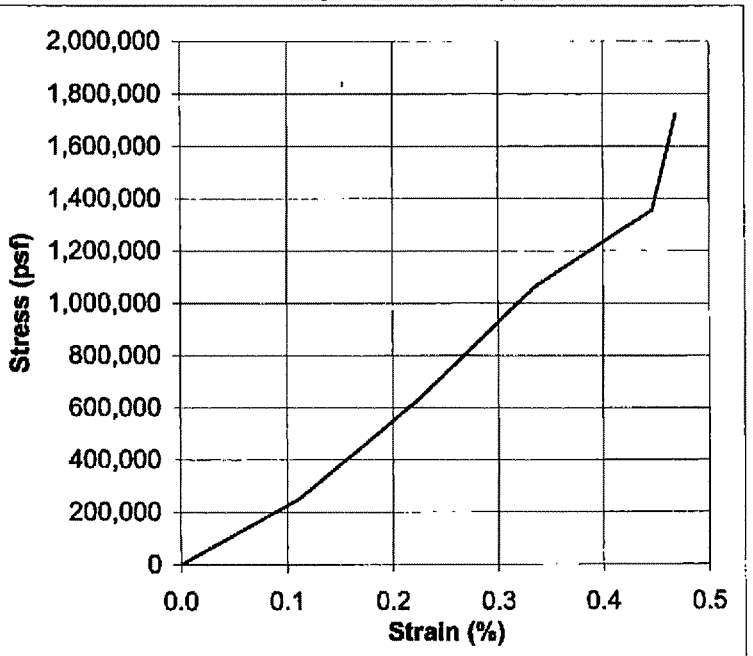


WATER CONTENT AFTER SHEAR	
CAN NUMBER	t24
WET WEIGHT + CAN (lbs.)	2.03
DRY WEIGHT + CAN (lbs.)	2.03
WEIGHT WATER (lbs.)	0.01
WEIGHT CAN (lbs.)	0.90
WEIGHT SOLID (lbs.)	1.13
MOISTURE (%)	**0.5**

PROVING RING NO.: QC200

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
5	4,715	4,715	0.1	249,878
10	11,845	11,845	0.2	627,743
15	20,075	20,075	0.3	1,063,904
20	25,595	25,595	0.4	1,356,444
21	32,550	32,550	0.5	1,725,034

TEST TEMPERATURE: 70°F



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**0.1**
STRAIN AT FAILURE (%)	**0.5**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**1,725.0**
SHEAR STRENGTH (ksf)	**862.5**

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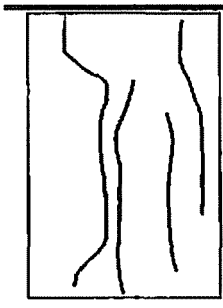
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 9 SAMPLE NUMBER: RC DEPTH (ft.): 29.8-30.2
SAMPLE DESCRIPTION: Gray trace brown slightly weathered limestone
BEDROCK FORMATION: Fairview Formation DATE: 1/27/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.86
HEIGHT (in.)	3.77
HEIGHT TO DIAMETER RATIO	2.03
AVERAGE AREA (sq. ft.)	0.0189
VOLUME (cu. ft.)	0.0059
WET WEIGHT (lbs.)	0.99
DRY WEIGHT (lbs.)	0.99
DRY DENSITY (pcf)	**166.5**

FAILURE SHAPE

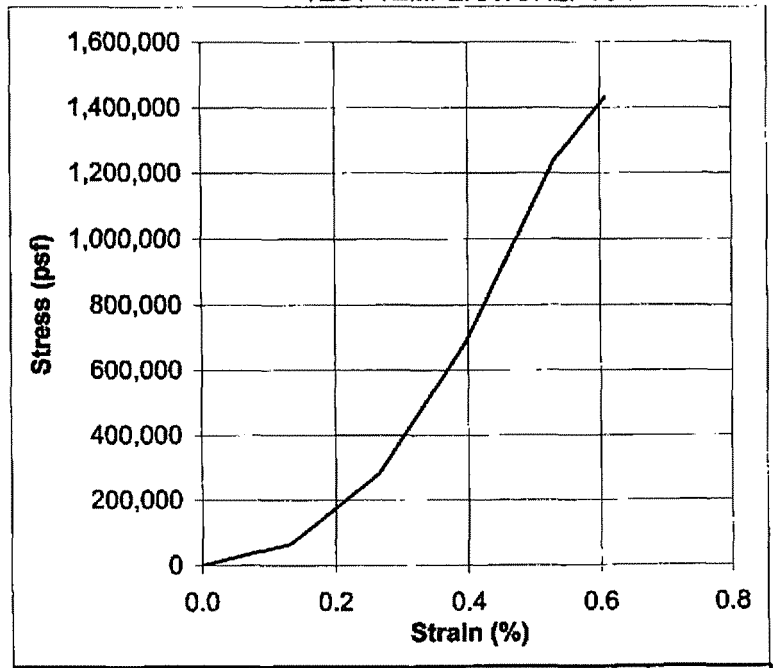


WATER CONTENT AFTER SHEAR	
CAN NUMBER	a13
WET WEIGHT + CAN (lbs.)	1.86
DRY WEIGHT + CAN (lbs.)	1.86
WEIGHT WATER (lbs.)	0.00
WEIGHT CAN (lbs.)	0.89
WEIGHT SOLID (lbs.)	0.97
MOISTURE (%)	**0.2**

PROVING RING NO.: QC200

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
5	1,225	1,225	0.1	64,921
10	5,285	5,285	0.3	280,086
15	13,035	13,035	0.4	690,809
20	23,355	23,355	0.5	1,237,732
23	27,030	27,030	0.6	1,432,494

TEST TEMPERATURE: 70°F



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**0.2**
STRAIN AT FAILURE (%)	**0.6**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**1,432.5**
SHEAR STRENGTH (ksf)	**716.2**

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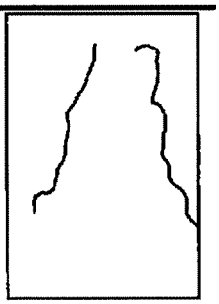
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 9 SAMPLE NUMBER: RC DEPTH (ft.): 33.4-33.9
SAMPLE DESCRIPTION: Gray little brown moderately weathered shale
BEDROCK FORMATION: Fairview Formation DATE: 1/23/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.86
HEIGHT (in.)	4.25
HEIGHT TO DIAMETER RATIO	2.28
AVERAGE AREA (sq. ft.)	0.0189
VOLUME (cu. ft.)	0.0067
WET WEIGHT (lbs.)	0.98
DRY WEIGHT (lbs.)	0.87
DRY DENSITY (pcf)	**130.5**

FAILURE SHAPE

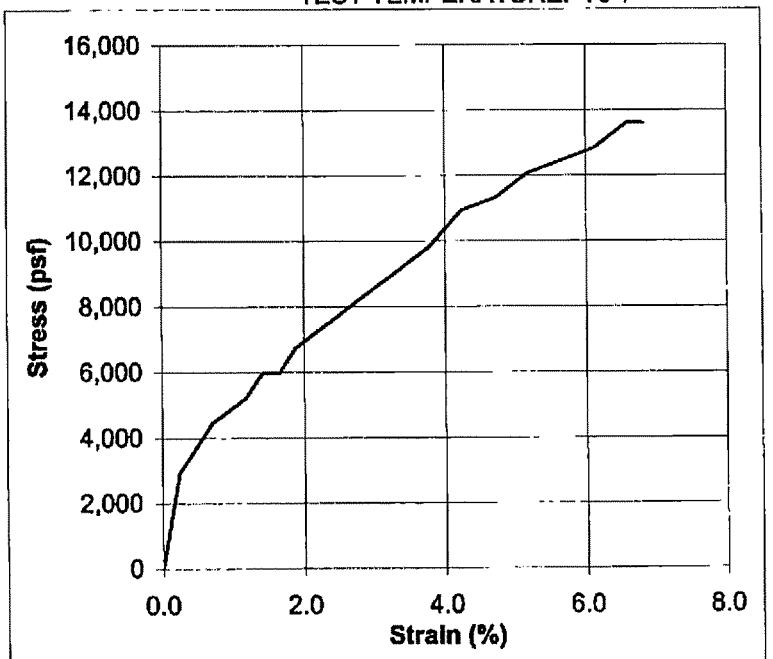


WATER CONTENT AFTER SHEAR	
CAN NUMBER	t4
WET WEIGHT + CAN (lbs.)	1.90
DRY WEIGHT + CAN (lbs.)	1.79
WEIGHT WATER (lbs.)	0.11
WEIGHT CAN (lbs.)	0.92
WEIGHT SOLID (lbs.)	0.87
MOISTURE (%)	**12.5**

PROVING RING NO.: 19901

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
10	2	55	0.2	2,926
20	4	70	0.5	3,688
30	6	84	0.7	4,451
40	7	91	0.9	4,832
50	8	98	1.2	5,214
60	10	113	1.4	5,976
70	10	113	1.6	5,976
80	12	127	1.9	6,739
100	14	142	2.4	7,501
120	16	156	2.8	8,264
140	18	170	3.3	9,026
160	20	185	3.8	9,789
180	23	206	4.2	10,932
200	24	213	4.7	11,314
220	26	228	5.2	12,076
240	27	235	5.6	12,457
260	28	242	6.1	12,839
270	29	249	6.4	13,220
280	30	257	6.6	13,601
290	30	257	6.8	13,601

TEST TEMPERATURE: 70°F



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**1.4**
STRAIN AT FAILURE (%)	**6.6**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**13.6**
SHEAR STRENGTH (ksf)	**6.8**

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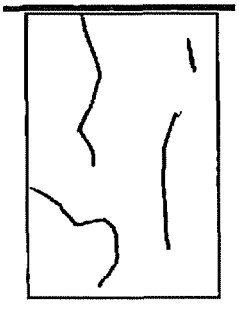
UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE, ASTM - D2938
UNIT WEIGHT AND NATURAL MOISTURE

CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP
LOCATION: Ft. Thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 9 SAMPLE NUMBER: RC DEPTH (ft.): 48.3-48.8
SAMPLE DESCRIPTION: Gray unweathered shale
BEDROCK FORMATION: Fairview Formation DATE: 1/23/2009
SAMPLE OBTAINED BY: Rock Core CONDITION: Undisturbed LOAD DIRECTION 90° TO LITHOLOGY

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	1.85
HEIGHT (in.)	4.27
HEIGHT TO DIAMETER RATIO	2.31
AVERAGE AREA (sq. ft.)	0.0187
VOLUME (cu. ft.)	0.0067
WET WEIGHT (lbs.)	1.05
DRY WEIGHT (lbs.)	0.99
DRY DENSITY (pcf)	**148.9**

FAILURE SHAPE

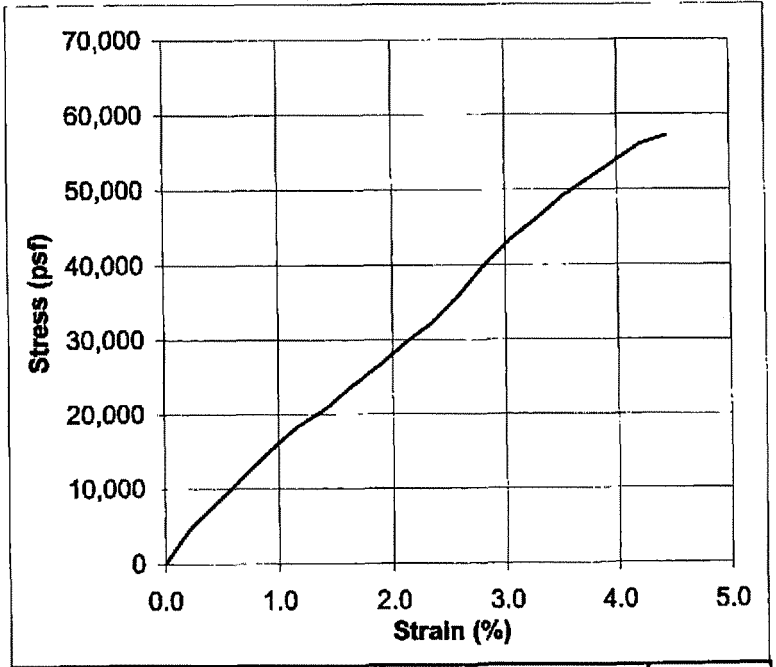


WATER CONTENT AFTER SHEAR	
CAN NUMBER	kp1
WET WEIGHT + CAN (lbs.)	1.98
DRY WEIGHT + CAN (lbs.)	1.92
WEIGHT WATER (lbs.)	0.06
WEIGHT CAN (lbs.)	0.93
WEIGHT SOLID (lbs.)	0.99
MOISTURE (%)	**5.6**

PROVING RING NO.: 19901

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 in.)	LOAD (lbs.)	STRAIN (%)	STRESS (psf)
0	0	0	0.0	0
10	7	91	0.2	4,874
20	16	156	0.5	8,335
30	25	221	0.7	11,796
40	34	285	0.9	15,257
50	42	343	1.2	18,334
60	48	386	1.4	20,641
70	56	444	1.6	23,717
80	63	494	1.9	26,409
90	71	552	2.1	29,486
100	78	602	2.3	32,178
110	87	667	2.6	35,639
120	98	746	2.8	39,869
130	107	811	3.0	43,330
140	114	861	3.3	46,022
150	122	918	3.5	49,098
160	128	962	3.7	51,406
170	134	1,005	4.0	53,713
180	140	1,048	4.2	56,020
190	143	1,070	4.4	57,174

TEST TEMPERATURE: 70°F



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**1.8**
STRAIN AT FAILURE (%)	**4.4**
UNCONFINED COMPRESSIVE STRENGTH (ksf)	**57.2**
SHEAR STRENGTH (ksf)	**28.6**

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING #: 1

PROJECT: Geotechnical Exploration, Advanced Treatment GAC-FTTP, Ft. Thomas, Kentucky JOB #: 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH (feet)	DEPTH SCALE (feet)	SAMPLE Cond	Blows/6"	No.	Type	Rec. (Inches)
793.7	SURFACE	0.0						
791.7	Mixed brown trace gray moist medium stiff FILL, silty clay, trace topsoil and hairlike roots.	2.0		I	1/1/3	1	DS	17
	Interbedded brown moist extremely weak highly weathered SHALE and gray strong to very strong LIMESTONE (bedrock).		5	I	50/3"	2	DS	2
				I	16/50/5"	3	DS	11
				I	3/33/20	4	DS	17
			10	I	50/3"	5	DS	3
781.7		12.0						
778.3	Interbedded gray, trace brown moist extremely weak moderately weathered SHALE and gray strong to very strong LIMESTONE (bedrock).	15.4	15	I	18/31/50/4"	6	DS	16
	Bottom of test boring at 15.4 feet.			I	50/4"	7	DS	4
			20					
			25					

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 8 in. Foreman JS / TD-2

Surf. Elev. 793.7 ft. Hammer Drop 30 in. Rock Core Dia. – in. Engineer LJC

Date Started 1/9/09 Pipe Size O.D. 2 in. Boring Method 3-1/4" HSA Date Completed 1/9/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUNDWATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER 6 days Dry ft.
BACKFILLED 6 days

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill — BORING #: 2 (1 of 2)

PROJECT: Geotechnical Exploration, Advanced Treatment GAC-FTTP, Ft. Thomas, Kentucky — JOB #: 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH (feet)	DEPTH SCALE (feet)	SAMPLE Cond	Blows/6"	No.	Type	Rec. (Inches)
792.0	SURFACE	0.2						
791.8	TOPSOIL (2-½ inches)			I	1/2/2	1A 1B	DS	18
790.0	Mixed brown moist medium stiff FILL, silty clay, trace hairlike roots, shale and limestone fragments.	2.0		I	50/2"	2	DS	2
782.5	Interbedded brown moist extremely weak highly weathered SHALE and gray strong to very strong LIMESTONE (bedrock).		5	I	50/3"	3	DS	1
781.0	Interbedded brown some gray moist very weak moderately weathered SHALE and gray strong to very strong LIMESTONE (bedrock).			I	21/50/6"	4	DS	9
779.0	Interbedded brown moist extremely weak to weak moderately weathered thin to medium bedded SHALE, and gray trace brown strong to very strong slightly weathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 1 to 5-inch beds, and comprises 49.0% of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). (Fairview Formation Bedrock)	9.5 11.0 13.0	10	I	32/50/6"	5	DS	11
					RQD= 21%	6	RC	21
774.0	Interbedded brown moist extremely weak to weak moderately to slightly weathered thin to medium bedded SHALE, and gray trace brown strong to very strong slightly weathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 1 to 4-inch beds, and comprises 42.0% of this interval. This interval contains occasional soft clay seams (≤ 1-inch thickness). (Fairview Formation Bedrock)	18.0	15		RQD = 25%	7	RC	60/60
769.0	Interbedded brown, little gray moist extremely weak to weak moderately weathered to unweathered thin to medium bedded SHALE, and gray trace brown strong to very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 1 to 5-inch beds, and comprises 30.0% of this interval. This interval contains occasional soft clay seams (≤ 1-inch thickness). (Fairview Formation Bedrock)	23.0	20		RQD = 42%	8	RC	60/60
764.0	Interbedded gray, trace brown strong to very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE, and brown little gray moist extremely weak to weak moderatley weathered to unweathered thin to medium bedded SHALE. The limestone occurs in 1 to 6-½-inch beds, and comprises 55% of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). (Fairview Formation Bedrock)	28.0	25		RQD = 23%	9	RC	57/60
					RQD = 63%	10	RC	54/60

Datum MSL — Hammer Wt. 140 lbs. — Hole Diameter 8 in. — Foreman JS / TD-2

Surf. Elev. 792.0 ft. — Hammer Drop 30 in. — Rock Core Dia. 1-7/8 in. — Engineer LJC

Date Started 1/9/09 — Pipe Size O.D. 2 in. — Boring Method 3-1/4" HSA — Date Completed 1/9/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUNDWATER DEPTH
FIRST NOTED Core Water ft.
AT COMPLETION Core Water ft.
AFTER 7 days 9.4 ft.
BACKFILLED 7 days

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill — BORING #: 2 (2 of 2)

PROJECT: Geotechnical Exploration, Advanced Treatment GAC-FTTP, Ft. Thomas, Kentucky — JOB #: 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH (feet)	DEPTH SCALE (feet)	SAMPLE Cond	Blows/6"	No.	Type	Rec. (Inches)
762.0			30					
	Interbedded gray and brown moist extremely weak to very weak moderately weathered to unweathered thin to medium bedded SHALE, and gray trace brown strong to very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 1 to 5-inch beds, and comprises 30.0% of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). (Fairview Formation Bedrock)	33.0			RQD = 63%	10	RC	54/60
759.0			35		RQD = 29%	11	RC	60/60
	Interbedded gray, little brown moist extremely weak to weak extremely weathered to unweathered thin to medium bedded SHALE, and gray little brown very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 1 to 10-inch beds, and comprises 35.0 % of this interval. This interval contains occasional soft clay seams (≤ 1-inch thickness). (Fairview Formation Bedrock)	38.0	40					
754.0								
	Bottom of test boring at 38.0 feet.		45					
			50					
			55					

Datum MSL — Hammer Wt. 140 lbs. — Hole Diameter 8 in. — Foreman JS / TD-2

Surf. Elev. 792.0 ft. — Hammer Drop 30 in. — Rock Core Dia. 1-7/8 in. — Engineer LJC

Date Started 1/9/09 — Pipe Size O.D. 2 in. — Boring Method 3-1/4" HSA — Date Completed 1/9/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUNDWATER DEPTH
FIRST NOTED Core Water ft.
AT COMPLETION Core Water ft.
AFTER 7 days 9.4 ft.
BACKFILLED 7 days

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill — BORING #: 3 (1 of 2)

PROJECT: Geotechnical Exploration, Advanced Treatment GAC-FTTP, Ft. Thomas, Kentucky — JOB #: 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH (feet)	DEPTH SCALE (feet)	SAMPLE Cond	Blows/6"	No.	Type	Rec. (Inches)
802.4	SURFACE							
802.2	TOPSOIL (2-½ inches)	0.2		I	2/2/4	1A 1B	DS	18
800.4	Mixed brown moist medium stiff FILL, silty clay, trace hairlike roots and limestone fragments.	2.0		I	5/9/10	2	DS	3
797.9	Mixed brown moist stiff FILL, silty clay, some limestone and shale fragments and limestone floaters.	4.5	5	I	10/10/9	3	DS	15
795.4	Brown moist very stiff CLAY, little limestone fragments and shale floaters (CH).	7.0		I	9/14/33	4	DS	12
790.4	Interbedded brown moist very weak moderately weathered SHALE and gray strong to very strong LIMESTONE (bedrock).		10	I	24/50/6"	5	DS	11
787.4	Interbedded brown to olive brown and gray moist very weak moderately weathered SHALE and gray strong to very strong LIMESTONE (bedrock).	12.0		I	16/50/5"	6	DS	5
784.4	Interbedded brown moist extremely weak to weak moderately to slightly weathered thin to medium bedded SHALE and gray strong to very strong slightly weathered medium to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in ½ to 3-inch beds, and comprises 42.4 percent of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). Vertical fracture from 16.0 to 16.4 feet. (Fairview Formation Bedrock)	15.0	15		RQD = 15%	7	RC	28/36
779.4	Interbedded brown, trace gray moist extremely weak to weak, highly to moderately weathered thin to medium bedded SHALE, and gray trace brown strong to very strong slightly weathered to unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 1 to 6-inch beds, and comprises 40.8% of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). Vertical fractures from 18.5 to 18.9 feet and 19.4 to 19.7 feet. (Fairview Formation Bedrock)	18.0 23.0	20		RQD = 9%	8	RC	48/60
774.4	Interbedded brown and gray moist extremely weak to weak moderately to slightly weathered thin to medium bedded SHALE and gray trace brown strong to very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 1 to 8-inch beds, and comprises 48.8% of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). Vertical fractures from 24.1 to 24.2 feet and 26.9 to 27.0 feet. (Fairview Formation Bedrock)	28.0	25		RQD = 17% RQD = 43%	9 10	RC RC	54/60 60/60

Datum MSL — Hammer Wt. 140 lbs. — Hole Diameter 8 in. — Foreman JS / TD-2

Surf. Elev. 802.4 ft. — Hammer Drop 30 in. — Rock Core Dia. 1-7/8 in. — Engineer LJC

Date Started 1/5/09 — Pipe Size O.D. 2 in. — Boring Method 3-1/4" HSA — Date Completed 1/6/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUNDWATER DEPTH
FIRST NOTED Core Water ft.
AT COMPLETION Core Water ft.
AFTER 9 days Blocked @ 14.8 ft.
BACKFILLED 9 days

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill — BORING #: 3 (2 of 2)

PROJECT: Geotechnical Exploration, Advanced Treatment GAC-FTTP, Ft. Thomas, Kentucky — JOB #: 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH (feet)	DEPTH SCALE (feet)	SAMPLE Cond	Blows/6"	No.	Type	Rec. (inches)
722.4			30					
769.4	Interbedded gray some brown moist very weak to weak slightly weathered to unweathered thin to medium bedded SHALE and gray trace brown strong to very strong unweathered fine to coarse crystalline grained medium bedded LIMESTONE. The limestone occurs in 2 to 9-inch beds, and coprises 45.8% of this interval. This interval contains occasional soft clay seams (≤ 1-inch thickness). Vertical fracture from 28.7 to 28.9 feet. (Fairview Formation Bedrock)	33.0			RQD = 43%	10	RC	60/60
764.4	Interbedded brown and gray moist extremely weak to weak moderately to slightly weathered thin to medium bedded SHALE and gray strong to very strong unweathered fine to coarse crystalline grained thin to medium bedded LIMESTONE. The limestone occurs in ½ to 6-inch beds, and comprises 39.6% of this interval. This interval contains occasional soft clay seams (≤ 1-inch thickness). Vertical fracture from 33.3 to 33.4 feet. (Fairview Formation Bedrock)	38.0	35		RQD = 60%	11	RC	60/60
754.4	Interbedded gray some brown moist very weak to weak slightly weathered to unweathered thin to medium bedded SHALE, and gray very strong unweathered fine to coarse crystalline grained thin to medium bedded LIMESTONE. The limestone occurs in 1 to 12-inch beds, and comprises 29.2% of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). Vertical fracture from 38.4 to 38.9 feet. (Fairview Formation Bedrock)		40		RQD = 29%	12	RC	76.5/120
744.4	Interbedded gray, trace brown moist very weak to weak slightly weathered to unweathered thin to medium bedded SHALE, and gray very strong unweathered fine to coarse crystalline grained thin to medium bedded LIMESTONE. The limestone occurs in ½ to 7-inch beds, and comprises 32.7% of this interval, assuming the unrecovered core to be shale. (Fairview Formation Bedrock)	48.0	45		Note: Scale Change			
738.4	Interbedded gray moist very weak to weak slightly weathered thin to medium bedded SHALE, some gray very strong unweathered fine to coarse crystalline grained thin to medium bedded LIMESTONE. The limestone occurs in 1 to 4-inch beds and comprises 25.7% of this interval, assuming the unrecovered core to be shale. (Fairview Formation Bedrock) Note: Limestone fragment stuck in core barrel ground up the majority of shale in this interval.	58.0 64.0	50 55 60 65		RQD = 15% RQD = 0%	13 14	RC RC	102/120 24/72
	Bottom of test boring at 64.0 feet.							

Datum MSL — Hammer Wt. 140 lbs. — Hole Diameter 8 in. — Foreman JS / TD-2

Surf. Elev. 802.4 ft. — Hammer Drop 30 in. — Rock Core Dia. 1-7/8 in. — Engineer LJC

Date Started 1/5/09 — Pipe Size O.D. 2 in. — Boring Method 3-1/4" HSA — Date Completed 1/5/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUNDWATER DEPTH
FIRST NOTED Core Water ft.
AT COMPLETION Core Water ft.
AFTER 9 days Blocked @ 14.8 ft.
BACKFILLED 9 days

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING #: 4 (1 of 2)

PROJECT: Geotechnical Exploration, Advanced Treatment GAC-FTTP, Ft. Thomas, Kentucky JOB #: 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH (feet)	DEPTH SCALE (feet)	SAMPLE Cond	Blows/6"	No.	Type	Rec. (inches)
809.3	SURFACE	0.3						
809.0	TOPSOIL (4 inches)	2.0		I	1/1/3	1	DS	15
807.3	Mixed brown, trace gray moist medium stiff FILL, silty clay, trace topsoil, hairlike roots, shale fragments.	4.5		I	3/4/7	2	DS	18
804.8	Mixed brown, trace gray moist stiff FILL, silty clay, little shale fragments and iron oxide stains.	7.0	5	I	9/9/14	3	DS	18
802.3	Brown, trace gray moist very stiff FILL, shale (floater).	9.5		I	5/5/7	4	DS	18
799.8	Brown, trace gray moist very stiff SILTY CLAY, some shale fragments and iron oxide stains.	12.0	10	I	29/43/47	5	DS	18
797.3	Interbedded brown, trace gray moist extremely weak highly weathered SHALE and gray strong to very strong LIMESTONE (bedrock).	14.0		I	25/50/3"	6	DS	8
795.3	Interbedded brown, trace gray moist extremely weak highly weathered SHALE and brown, trace gray strong to very strong weathered LIMESTONE (bedrock).	17.0	15	I	27/50/6"	7	DS	12
792.3	Interbedded brown, trace gray moist very weak moderately weathered SHALE and gray, trace brown strong to very strong LIMESTONE (bedrock).	19.5		I	50/2"	8	DS	2
789.8	Interbedded brown moist very weak moderately weathered SHALE and gray strong to very strong LIMESTONE (bedrock).		20	I	22/33/50	9	DS	17
				I	50/6"	10	DS	5
	Interbedded gray, trace brown moist very weak moderately weathered SHALE and gray strong to very strong LIMESTONE (bedrock).		25					
781.3		28.0		I	16/50/5"	11	DS	11

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 8 in. Foreman JS / TD-2

Surf. Elev. 809.3 ft. Hammer Drop 30 in. Rock Core Dia. -- in. Engineer LJC

Date Started 12/31/08 Pipe Size O.D. 2 in. Boring Method 3-1/4" HSA Date Completed 12/31/08

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUNDWATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER 16 days 17.6 ft.
BACKFILLED 16 days

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill — BORING #: 4 (2 of 2)

PROJECT: Geotechnical Exploration, Advanced Treatment GAC-FTTP, Ft. Thomas, Kentucky — JOB #: 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH (feet)	DEPTH SCALE (feet)	SAMPLE Cond	Blows/6"	No.	Type	Rec. (Inches)
779.3			30					
776.3	Interbedded brown, trace olive brown moist very weak moderately weathered SHALE and gray strong to very strong LIMESTONE (bedrock).	33.0		I	50/6"	12	DS	6
			35	I	50/6"	13	DS	6
764.2	Interbedded brown and gray moist very weak slightly weathered SHALE and gray slightly weathered strong LIMESTONE (bedrock).	45.1	40	I	50/5"	14	DS	5
	Bottom of Test Boring at 45.1 feet.		45	I	50/1"	15	DS	1"
			50					
			55					

Datum MSL — Hammer Wt. 140 lbs. — Hole Diameter 8 in. — Foreman JS / TD-2

Surf. Elev. 809.3 ft. — Hammer Drop 30 in. — Rock Core Dia. -- in. — Engineer LJC

Date Started 12/31/08 — Pipe Size O.D. 2 in. — Boring Method 3-1/4" HSA — Date Completed 12/31/08

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUNDWATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER 16 days 17.6 ft.
BACKFILLED 16 days

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill — BORING #: 5 (1 of 2)

PROJECT: Geotechnical Exploration, Advanced Treatment GAC-FTTP, Ft. Thomas, Kentucky — JOB #: 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH (feet)	DEPTH SCALE (feet)	SAMPLE Cond	Blows/6"	No.	Type	Rec. (Inches)
792.9	SURFACE	0.0						
790.9	Mixed brown and gray moist medium stiff FILL, silty clay, limestone, and shale, trace topsoil and hairlike roots.	2.0		I	2/2/5	1	DS	17
787.4	Interbedded brown some gray moist extremely weak highly weathered SHALE and gray strong to very strong LIMESTONE (bedrock).	5.5		I	19/50/6"	2	DS	12
779.9	Interbedded brown moist extremely weak to very weak highly to moderately weathered thin to medium bedded SHALE, and gray trace brown medium to very strong slightly weathered to unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in ½ to 7-inch beds, and comprises 36.6 % of this interval, assuming the unrecovered core to be shale. Vertical fractures from 6.1 to 6.4 feet; 7.4 to 7.8 feet; and 8.6 to 9.0 feet. This interval contains occasional soft clay seams (≤ 1-inch thickness). (Fairview Formation Bedrock)	13.0	5 10		50/6"	3	DS	4
					RQD = 15%	4	RC	61/90
774.9	Interbedded brown, trace gray moist extremely weak to very weak moderately to slightly weathered thin to medium bedded SHALE, and gray medium to very strong slightly unweathered medium to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 1 to 5-inch beds, and comprises 44.2 % of this interval, assuming the unrecovered core to be shale. (Fairview Formation Bedrock)	18.0	15		RQD = 33%	5	RC	54/60
769.9	Interbedded gray and brown moist extremely weak to weak moderately to slightly weathered thin to medium bedded SHALE, some gray very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. This limestone occurs in 1 to 10-inch beds, and comprises 35.0 % of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). Vertical fracture from 20.8 to 21.0 feet. (Fairview Formation Bedrock)	23.0	20		RQD = 57%	6	RC	58/60
764.9	Interbedded gray, trace brown very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE, and brown and gray moist extremely weak to weak moderately to slightly weathered thin to medium bedded SHALE. The limestone occurs in 1 to 8-inch beds, and comprises 52.1 % of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). Vertical fracture from 25.0 to 25.1 feet. (Fairview Formation Bedrock)	28.0	25		RQD = 74%	7	RC	59/60
					RQD = 56%	8	RC	60/60

Datum MSL — Hammer Wt. 140 lbs. — Hole Diameter 8 in. — Foreman JS / TD-2

Surf. Elev. 792.9 ft. — Hammer Drop 30 in. — Rock Core Dia. 1-7/8 in. — Engineer LJC

Date Started 1/11/09 — Pipe Size O.D. 2 in. — Boring Method 3-1/4" HSA — Date Completed 1/11/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUNDWATER DEPTH
FIRST NOTED Core Water ft.
AT COMPLETION Core Water ft.
AFTER 4 days Caved @ 4.9 ft.
BACKFILLED 4 days

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill — BORING #: 5 (2 of 2)

PROJECT: Geotechnical Exploration, Advanced Treatment GAC-FTTP, Ft. Thomas, Kentucky — JOB #: 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH (feet)	DEPTH SCALE (feet)	SAMPLE Cond	Blows/6"	No.	Type	Rec. (Inches)
762.9			30					
759.9	Interbedded gray and brown moist very weak to weak moderately to slightly weathered thin to medium bedded SHALE, and gray strong to very strong slightly weathered to unweathered medium to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in ½ to 4-inch beds, and comprises 42.9 % of this interval. Vertical fracture from 29.8 to 30.0 feet. (Fairview Formation Bedrock)	33.0	35		RQD = 56%	8	RC	60/60
754.9	Interbedded gray some brown moist very weak to weak slightly weathered to unweathered thin to medium bedded SHALE, and gray strong slightly weathered to unweathered medium to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in ½ to 5-inch beds, and comprises 23.3 % of this interval, assuming the unrecovered core to be shale. (Fairview Formation Bedrock)	38.0	40		RQD = 53%	9	RC	55/60
749.9	Interbedded gray some brown moist very weak to weak slightly weathered to unweathered thin to medium bedded SHALE, and gray, trace brown strong to very strong slightly weathered to unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in ½ to 3-inch beds, and comprises 28.3% of this interval. (Fairview Formation Bedrock).	43.0	45		RQD = 35%	10	RC	60/60
744.9	Interbedded gray, trace brown moist very weak to weak slightly weathered to unweathered thin to medium bedded SHALE, and gray, trace brown strong to very strong slightly weathered to unweathered medium to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 1 to 6-inch beds, and comprises 28.3% of this interval. (Fairview Formation Bedrock)	48.0	50		RQD = 56%	11	RC	60/60
739.9	Interbedded gray, trace brown very weak to weak slightly weathered to unweathered thin to medium bedded SHALE, some gray, trace brown strong to very strong unweathered medium coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 1 to 4-½-inch beds, and comprises 31.3 % of this interval. (Fairview Formation Bedrock)	53.0	55		RQD = 50%	12	RC	60/60
	Bottom of test boring at 53.0 feet.							

Datum MSL — Hammer Wt. 140 lbs. — Hole Diameter 8 in. — Foreman JS / TD-2

Surf. Elev. 792.9 ft. — Hammer Drop 30 in. — Rock Core Dia. 1-7/8 in. — Engineer LJC

Date Started 1/11/09 — Pipe Size O.D. 2 In. — Boring Method 3-1/4" HSA — Date Completed 1/11/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUNDWATER DEPTH
FIRST NOTED Core Water ft.
AT COMPLETION Core Water ft.
AFTER 4 days Caved @ 4.9 ft.
BACKFILLED 4 days

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill — BORING #: 6 (1 of 2)

PROJECT: Geotechnical Exploration, Advanced Treatment GAC-FTTP, Ft. Thomas, Kentucky — JOB #: 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH (feet)	DEPTH SCALE (feet)	SAMPLE Cond	Blows/6"	No.	Type	Rec. (Inches)
805.4	SURFACE	0.2						
805.2	TOPSOIL (2-½ inches)			I	1/1/9	1A 1B	DS	18
803.4	Mixed brown, trace gray moist medium stiff FILL, silty clay, some limestone and shale fragments, limestone floaters, trace hairlike roots (CL).	2.0		I	17/50/5"	2	DS	18
795.9	Interbedded brown, trace gray extremely weak highly weathered SHALE and gray strong to very strong LIMESTONE (bedrock).		5	I	20/24/50/3"	3	DS	18
	Interedded brown moist extremely to very weak moderately weathered thin to medium bedded SHALE, and gray trace brown strong to very strong slightly weathered to unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 1 to 5-inch beds, and comprises 47.2% of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). (Fairview	9.5		I	19/50/6"	4	DS	18
793.4	Formation Bedrock)		10		50/6"	5	DS	12
	Interbedded brown and gray moist extremely to very weak moderately to slightly weathered thin to medium bedded SHALE, and gray trace brown strong to very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 1 to 5-inch beds, and comprises 26.7% of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). Fractured	12.0			RQD = 28%	6	RC	14/18
788.4	zone from 12.3 to 12.7 feet. (Fairview Formation Bedrock)	17.0	15		RQD = 80%	7	RC	59/60
	Interbedded brown, some gray moist extremely weak to weak moderately weathered thin to medium bedded SHALE, and gray little brown strong to very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in ½ to 5-inch beds, and comprises 44.2% of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). Vertical	22.0	20		RQD = 52%	8	RC	57/60
783.4	fractures from 17.6 to 17.7 feet and 18.2 to 18.3 feet. (Fairview Formation Bedrock)				RQD = 20%	9	RC	55/60
	Interbedded gray and brown moist extremely weak to weak slightly weathered to unweathered thin to medium bedded SHALE, and gray trace brown strong to very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 1 to 5-½-inch beds, and comprises 35.8% of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). Fractured	27.0	25					
778.4	zone from 23.3 to 23.5 feet. (Fairview Formation Bedrock)				RQD = 58%	10	RC	60/60

Datum MSL — Hammer Wt. 140 lbs. — Hole Diameter 8 in. — Foreman JS / TD-2

Surf. Elev. 805.4 ft. — Hammer Drop 30 in. — Rock Core Dia. 1-7/8 in. — Engineer LJC

Date Started 1/7/09 — Pipe Size O.D. 2 in. — Boring Method 3-1/4" HSA — Date Completed 1/8/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUNDWATER DEPTH
FIRST NOTED Core Water ft.
AT COMPLETION Core Water ft.
AFTER 90 days 38 ft.
BACKFILLED 7 days

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill — BORING #: 6 (2 of 2)

PROJECT: Geotechnical Exploration, Advanced Treatment GAC-FTTP, Ft. Thomas, Kentucky — JOB #: 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH (feet)	DEPTH SCALE (feet)	SAMPLE Cond	Blows/6"	No.	Type	Rec. (Inches)
775.4			30					
773.4	Interbedded gray, some brown moist extremely weak to weak moderately to slightly weathered thin to medium bedded SHALE, and gray little brown strong to very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. Limestone occurs in 1 to 5-¼-inch beds, and comprises 36.0 % of this interval. This interval contains occasional soft clay seams (≤ 1-inch thickness). Vertical fracture from 28.8 to 29.0 feet. (Fairview Formation Bedrock)	32.0			RQD = 58%	10	RC	60/60
768.4	Interbedded gray, trace brown strong to very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE and brown and gray, trace olive brown moist extremely to very weak moderately weathered to unweathered thin to medium bedded SHALE. The limestone occurs in ½ to 5-inch beds, and comprises 52.5 % of this interval. This interval contains occasional soft clay seams (≤ 1-inch thickness). (Fairview Formation Bedrock)	37.0	35		RQD = 18%	11	RC	60/60
763.4	Interbedded gray, some brown moist extremely weak to weak moderately to slightly weathered thin to medium bedded SHALE, and gray trace brown strong to very strong slightly weathered to unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 1 to 6-½-inch beds, and comprises 47.5 % of this interval. This interval contains occasional soft clay seams (≤ 1-inch thickness). (Fairview Formation Bedrock)	42.0	40		RQD = 11%	12	RC	60/60
758.4	Interbedded gray, some brown moist extremely weak to weak slightly weathered thin to medium bedded SHALE, and gray little brown very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in ½ to 9-inch beds, and comprises 42.9 % of this interval, assuming the unrecovered core to be shale. Vertical fracture from 44.8 to 45.5 feet. (Fairview Formation Bedrock)	47.0	45		RQD = 38%	13	RC	54/60
753.4	Interbedded gray, trace brown moist very weak to weak slightly weathered thin to medium bedded SHALE, and gray trace brown strong to very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in ½ to 4-inch beds, and comprises 37.9% of this interval, assuming the unrecovered core to be shale. (Fairview Formation Bedrock)	52.0	50		RQD = 45%	14	RC	54/60
748.4	Interbedded gray, trace brown very weak to weak slightly weathered thin to medium bedded SHALE, and gray very strong fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 3 to 8-inch beds, and comprises 47.1 % of this interval. Vertical fracture from 54.2 to 54.3 feet. (Fairview Formation Bedrock) Bottom of test boring at 57.0 feet.	57.0	55		RQD = 43%	15	RC	60/60
	Note: Piezometer installed to 57' depth prior to backfill.							

Datum 805.4 — Hammer Wt. 140 lbs. — Hole Diameter 8 in. — Foreman JS / TD-2

Surf. Elev. 804.0 ft. — Hammer Drop 30 in. — Rock Core Dia. 1-7/8 in. — Engineer LJC

Date Started 1/7/09 — Pipe Size O.D. 2 in. — Boring Method 3-1/4" HSA — Date Completed 1/8/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUNDWATER DEPTH
FIRST NOTED Core Water ft.
AT COMPLETION Core Water ft.
AFTER 90 days 38 ft.
BACKFILLED 7 days

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING #: 7

PROJECT: Geotechnical Exploration, Advanced Treatment GAC-FTTP, Ft. Thomas, Kentucky JOB #: 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH (feet)	DEPTH SCALE (feet)	SAMPLE Cond	Blows/6"	No.	Type	Rec. (Inches)
813.9	SURFACE	0.4						
813.5	TOPSOIL (5 inches)	2.0		I	1/2/4	1A 1B	DS	17
811.9	Mixed brown, trace gray moist medium stiff FILL, silty clay with limestone and shale fragments.			I	8/50/3"	2	DS	6
804.9	Brown, trace gray moist extremely weak highly weathered SHALE and gray strong to very strong LIMESTONE (bedrock).	9.0	5	I	23/43/20	3	DS	12
				I	41/40/50	4	DS	15
801.9	Interbedded gray and olive brown moist extremely weak highly weathered SHALE and gray strong to very strong LIMESTONE (bedrock).	12.0	10	I	31/33/50/4"	5	DS	16
798.5	Interbedded brown, trace gray moist very weak moderately weathered SHALE and gray strong to very strong LIMESTONE (bedrock).	15.4	15	I	50/3"	6	DS	3
	Bottom of test boring at 15.4 feet.			I	50/5"	7	DS	5
			20					
			25					

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 8 in. Foreman JS / TD-2

Surf. Elev. 813.9 ft. Hammer Drop 30 in. Rock Core Dia. -- in. Engineer LJC

Date Started 1/5/09 Pipe Size O.D. 2 in. Boring Method 3-1/4" HSA Date Completed 1/5/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUNDWATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER 10 days 8.6 ft.
BACKFILLED 10 days

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING #: 8

PROJECT: Geotechnical Exploration, Advanced Treatment GAC-FTTP, Ft. Thomas, Kentucky JOB #: 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH (feet)	DEPTH SCALE (feet)	SAMPLE Cond	Blows/6"	No.	Type	Rec. (Inches)
780.6	SURFACE							
779.9	TOPSOIL (8 inches)	0.7		I	2/4/6	1A 1B	DS	16
778.6	Mixed brown some gray moist medium stiff FILL, silty clay, shale and limestone fragments and floaters, trace hairlike roots.	2.0						
776.1	Mixed brown, trace gray moist stiff FILL, silty clay, shale, and brick, trace topsoil and hairlike roots.	4.5		I	7/9/9	2	DS	4
774.6	Interbedded brown some gray moist extremely weak highly weathered SHALE and gray strong to very strong LIMESTONE (bedrock).	6.0	5	I	66/50/6"	3	DS	12
768.6	Interbedded brown, trace gray moist extremely to weak highly to moderately weathered thin to medium bedded SHALE and gray strong to very strong slightly weathered to unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 1 to 6-½ inch beds, and comprises 43.1 % of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). Vertical fracture from 6.2 to 6.4 feet. (Fairview Formation Bedrock)	12.0	10		RQD = 30%	4	RC	66/72
763.6	Interbedded brown to olive brown, some gray moist extremely to very weak highly to moderately weathered thin to medium bedded SHALE, and gray trace light brown strong to very strong slightly weathered to unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in ½ to 2-½ inch beds, and comprises 20% of this interval assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). Vertical fractures from 12.0 to 12.1 feet and 12.3 to 12.4 feet. (Fairview Formation Bedrock)	17.0	15		RQD = 0%	5	RC	39/60
758.6	Interbedded gray and brown moist extremely weak to weak moderately weathered thin to medium bedded SHALE and gray strong to very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs as lenses to 7-inch beds and comprises 47.5% of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). Vertical fractures from 19.2 to 19.3 feet and 21.5 to 21.7 feet. (Fairview Formation Bedrock)	22.0	20		RQD = 60%	6	RC	56/60
753.6	Interbedded gray, trace brown moist extremely to very weak moderately weathered to unweathered thin to medium bedded SHALE, and gray very strong slightly weathered to unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in ½ to 7-inch beds, and comprises 34.2 % of this interval. This interval contains occasional soft clay seam (≤ 1-inch thickness). (Fairview Formation Bedrock)	27.0	25		RQD = 58%	7	RC	60/60
	Bottom of test boring at 27.0 feet.							

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 8 in. Foreman JS / TD-2

Surf. Elev. 780.6 ft. Hammer Drop 30 in. Rock Core Dia. 1-7/8 in. Engineer LJC

Date Started 1/13/09 Pipe Size O.D. 2 in. Boring Method 3-1/4" HSA Date Completed 1/13/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUNDWATER DEPTH
FIRST NOTED Core Water ft.
AT COMPLETION Core Water ft.
AFTER 2 days Caved @ 4.0 ft.
BACKFILLED 2 days

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill — BORING #: 9 (1 of 2)

PROJECT: Geotechnical Exploration, Advanced Treatment GAC-FTTP, Ft. Thomas, Kentucky — JOB #: 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH (feet)	DEPTH SCALE (feet)	SAMPLE Cond	Blows/6"	No.	Type	Rec. (Inches)
794.1	SURFACE							
793.7	TOPSOIL (5 inches)	0.4						
792.1	Mixed brown, trace gray moist stiff FILL, silty clay, trace limestone and shale fragments.	2.0		I	3/5/3	1A 1B	DS	18
788.6	Interbedded brown, trace gray moist extremely weak highly weathered SHALE and gray strong to very strong LIMESTONE (bedrock).	5.5	5	I	16/27/36	2	DS	17
781.1	Interbedded brown, trace gray moist extremely weak highly to moderately weathered thin to medium bedded SHALE, and gray trace light brown very strong slightly weathered to unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in ½ to 4-inch beds and comprises 18.1 % of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). (Fairview Formation Bedrock)			I	50/6"	3	DS	5
776.1	Interbedded gray and brown moist extremely to very weak moderately weathered to slightly weathered thin to medium bedded SHALE, some gray trace light brown very strong slightly weathered to unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in ½ to 3-inch beds and comprises 33.3 % of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). (Fairview Formation Bedrock)	13.0	10		RQD = 0%	4	RC	27/90
771.1	Interbedded gray and brown moist extremely to very weak moderately to slightly weathered thin to medium bedded SHALE some gray very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 1 to 4-½ inch beds and comprises 28.8 % of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). Vertical fracture from 18.6 to 18.8 feet. (Fairview Formation Bedrock)	18.0	15		RQD = 15%	5	RC	48/60
766.1	Interbedded brown, little gray moist extremely to very weak moderately to slightly weathered thin to medium bedded SHALE, and gray very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 1-½ to 7-inch beds, and comprises 47.9 % of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). (Fairview Formation Bedrock)	23.0	20		RQD = 33%	6	RC	53/60
		28.0	25		RQD = 42%	7	RC	55/60
					RQD = 38%	8	RC	49/60

Datum MSL — Hammer Wt. 140 lbs. — Hole Diameter 8 in. — Foreman JS / TD-2

Surf. Elev. 794.1 ft. — Hammer Drop 30 in. — Rock Core Dia. 1-7/8 in. — Engineer LJC

Date Started 1/12/09 — Pipe Size O.D. 2 in. — Boring Method 3-1/4" HSA — Date Completed 1/12/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUNDWATER DEPTH
FIRST NOTED Core Water ft.
AT COMPLETION Core Water ft.
AFTER 3 days Caved @ 3.9 ft.
BACKFILLED 3 days

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

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LOG OF TEST BORING

CLIENT: CH2M Hill — BORING #: 9 (2 of 2)

PROJECT: Geotechnical Exploration, Advanced Treatment GAC-FTTP, Ft. Thomas, Kentucky — JOB #: 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH (feet)	DEPTH SCALE (feet)	SAMPLE Cond	Blows/6"	No.	Type	Rec. (inches)
764.1			30					
761.1	Interbedded gray and brown moist extremely to very weak moderately to slightly weathered thin to medium bedded SHALE, and gray very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 1 to 6-inch beds, and comprises 42.5% of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). (Fairview Formation Bedrock)	33.0			RQD = 38%	8	RC	49/60
756.1	Interbedded gray little brown moist extremely to very weak moderately to slightly weathered thin to medium bedded SHALE, and gray very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in ½ to 9-inch beds, and comprises 33.3% of this interval. (Fairview Formation Bedrock)	38.0	35		RQD = 79%	9	RC	60/60
751.1	Interbedded gray moist extremely to very weak slightly weathered to unweathered thin to medium bedded occasionally fossiliferous SHALE, and gray very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in ¾ to 3-½-inch beds, and comprises 35.8% of this interval. (Fairview Formation Bedrock)	43.0	40		RQD = 65%	10	RC	60/60
746.1	Interbedded gray moist extremely to very weak slightly weathered to unweathered thin to medium bedded occasionally fossiliferous SHALE, and gray very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in ½ to 4-½-inch beds and comprises 27.1% of this interval. (Fairview Formation Bedrock)	48.0	45		RQD = 27%	11	RC	60/60
741.1	Interbedded gray, trace brown moist extremely to very weak slightly weathered to unweathered thin to medium bedded SHALE, and gray very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 1-½ to 3-inch beds and comprises 27.5% of this interval. (Fairview Formation Bedrock)	53.0	50		RQD = 66%	12	RC	60/60
736.1	Interbedded gray moist very weak to weak unweathered thin to medium bedded fossiliferous SHALE, some gray very strong unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 1 to 4-½-inch beds, and comprises 26.7% of this interval. Vertical fractures from 53.0 to 53.2 feet and 57.0 to 57.2 feet.	58.0	55		RQD = 50%	13	RC	60/60
	Bottom of test borings at 58.0 feet.							

Datum MSL — Hammer Wt. 140 lbs. — Hole Diameter 8 in. — Foreman JS / TD-2

Surf. Elev. 794.1 ft. — Hammer Drop 30 in. — Rock Core Dia. 1-7/8 in. — Engineer LJC

Date Started 1/12/09 — Pipe Size O.D. 2 in. — Boring Method 3-1/4" HSA — Date Completed 1/12/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUNDWATER DEPTH
FIRST NOTED Core Water ft.
AT COMPLETION Core Water ft.
AFTER 3 days Caved @ 3.9 ft.
BACKFILLED 3 days

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING #: 10

PROJECT: Geotechnical Exploration, Advanced Treatment GAC-FTTP, Ft. Thomas, Kentucky JOB #: 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH (feet)	DEPTH SCALE (feet)	SAMPLE Cond	Blows/6"	No.	Type	Rec. (inches)
804.1	SURFACE	0.0						
803.4	TOPSOIL (8-½ inches)	0.7		I	1/2/4	1A	DS	18
		2.0				1B		
802.1	Mixed brown, trace gray moist medium stiff FILL, silty clay, trace limestone and shale fragments, trace topsoil.			I	17/24/39	2	DS	17
797.1	Interbedded brown moist extremely weak highly weathered SHALE and gray strong to very strong LIMESTONE (bedrock).	7.0	5	I	86/6"	3	DS	6
793.1	Interbedded gray, some brown moist extremely weak moderately weathered SHALE and gray strong to very strong LIMESTONE (bedrock).	11.0		I	50/6"	4	DS	6
			10	I	31/50/6"	5	DS	11
	Bottom of test boring at 11.0 feet.		15					
			20					
			25					

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 8 in. Foreman JS / TD-2

Surf. Elev. 804.1 ft. Hammer Drop 30 in. Rock Core Dia. – in. Engineer LJC

Date Started 1/13/9 Pipe Size O.D. 2 in. Boring Method 3-1/4" HSA Date Completed 1/13/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUNDWATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER 2 days Dry ft.
BACKFILLED 2 days

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

THELEN ASSOCIATES, INC.
Geotechnical • Testing Engineers
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LOG OF TEST BORING

CLIENT: CH2M Hill BORING #: 11

PROJECT: Geotechnical Exploration, Advanced Treatment GAC-FTTP, Ft. Thomas, Kentucky JOB #: 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH (feet)	DEPTH SCALE (feet)	SAMPLE Cond	Blows/6"	No.	Type	Rec. (Inches)
815.7	SURFACE	0.0						
806.2	Mixed brown, some gray moist medium stiff FILL, silty clay, some limestone and shale fragments, trace topsoil and hairlike roots (CL).			I	2/1/2	1	DS	16
802.7	Mixed brown and gray moist stiff FILL, silty clay, shale and limestone, trace topsoil and hairlike roots (CL).			I	4/5/7	2	DS	18
800.7	Interbedded brown and gray moist extremely weak highly weathered SHALE and gray strong LIMESTONE (bedrock).		5	I	8/10/13	3	DS	18
798.2	Interbedded gray moist extremely to very weak moderately weathered thin bedded SHALE and gray very strong unweathered medium to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in 1 to 4-inch beds, and comprises 47.5% of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams. (≤ 1-inch thickness). (Fairview Formation Bedrock)	9.5 13.0		I	7/6/6	4	DS	3
793.2	Interbedded gray little brown moist extremely to very weak moderately to slightly weathered thin to medium bedded SHALE, and gray, trace brown strong to very strong slightly weathered to unweathered fine to coarse crystalline grained thin to medium bedded fossiliferous LIMESTONE. The limestone occurs in ½ to 5-inch beds and comprises 28.8% of this interval, assuming the unrecovered core to be shale. This interval contains occasional soft clay seams (≤ 1-inch thickness). (Fairview Formation Bedrock)	15.0 17.5	10 15 20	I RQD = 16% RQD = 46%	5/5/11	6A 6B 7 8	DS RC RC	18 25/30 53/60
788.2	Interbedded gray some brown moist very weak to weak moderately weathered thin to medium bedded SHALE, some gray very strong unweathered fine to coarse crystalline grained thin to medium bedded fossilferous LIMESTONE. The limestone occurs in ½ to 6-inch beds and comprises 33.8% of this interval. This interval contains occasional soft clay seams (≤ 1-inch thickness). Vertical fracture from 23.8 to 24.0 feet. (Fairview Formation Bedrock)	22.5 27.5	25	RQD = 38%		9	RC	58/60
	Bottom of test boring at 27.5 feet.							

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 8 in. Foreman JS / TD-2

Surf. Elev. 815.7 ft. Hammer Drop 30 in. Rock Core Dia. 1-7/8 in. Engineer LJC

Date Started 1/13/09 Pipe Size O.D. 2 in. Boring Method 3-1/4" HSA Date Completed 1/13/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUNDWATER DEPTH
FIRST NOTED Core Water ft.
AT COMPLETION Core Water ft.
AFTER 2 days Caved @ 12.8 ft.
BACKFILLED 2 days

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING #: 12

PROJECT: Geotechnical Exploration, Advanced Treatment GAC-FTTP, Ft. Thomas, Kentucky JOB #: 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH (feet)	DEPTH SCALE (feet)	SAMPLE Cond	Blows/6"	No.	Type	Rec. (Inches)
782.8	SURFACE	0.2						
782.6	TOPSOIL (2-½ inches)	1.0		I	2/3/10	1A 1B 1C	DS	18
781.8	Mixed brown moist stiff FILL, silty clay, trace topsoil and hairlike roots.			I	34/50/6"	2	DS	11
	Interbedded brown moist extremely weak highly weathered SHALE and gray strong to very strong LIMESTONE (bedrock).		5	I	50/6"	3	DS	6
772.8		10.0		I	50/3"	4	DS	3
	Bottom of test boring at 10.0 feet.		10					
	Note: Piezometer installed to 10 feet depth prior to backfill.		15					
			20					
			25					

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 8 in. Foreman JS / TD-2

Surf. Elev. 782.8 ft. Hammer Drop 30 in. Rock Core Dia. -- in. Engineer LJC

Date Started 1/11/09 Pipe Size O.D. 2 in. Boring Method 3-1/4" HSA Date Completed 1/11/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUNDWATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER 90 days Dry ft.
BACKFILLED 4 days

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING #: 13

PROJECT: Geotechnical Exploration, Advanced Treatment GAC-FTTP, Ft. Thomas, Kentucky JOB #: 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH (feet)	DEPTH SCALE (feet)	SAMPLE Cond	Blows/6"	No.	Type	Rec. (inches)
777.9	SURFACE	0.2						
777.7	TOPSOIL (2-½ inches)			I	2/4/15	1	DS	18
773.2	Mixed brown, trace gray moist medium stiff to stiff FILL, silty clay with limestone floaters, trace limestone and shale fragments, trace hairlike roots.	4.5		I	3/4/3	2	DS	18
770.9	Mixed brown, trace gray moist soft FILL, silty clay, trace limestone and shale fragments, trace hairlike roots.	7.0	5	I	2/2/6	3	DS	18
763.2	Mixed brown, trace gray moist stiff FILL, silty clay, shale and limestone floaters (CL).	14.5		I	22/14/4	4	DS	12
			10	I	5/3/3	5	DS	6
				I	46/14/14	6	DS	8
760.7	Brown, trace gray moist medium stiff SILTY CLAY, some shale fragments.	17.0	15	I	4/4/4	7	DS	16
758.2	Bluish green, some brown moist stiff SILTY CLAY with randomly oriented shale and limestone fragments (CL).	19.5		I	6/3/4	8	DS	18
753.9	Brown, trace gray moist stiff SILTY CLAY with randomly oriented shale and limestone fragments.	24.0	20	I	3/3/4	9	DS	18
					Note: Scale Change			
746.9	Interbedded brown moist extremely weak highly to moderately weathered SHALE and gray strong to very strong LIMESTONE (bedrock).	31.0	25	I	12/35/16	10	DS	12
			31	I	29/50/6"	11	DS	7
	Bottom of test boring at 31.0 feet.							

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 8 in. Foreman JS / TD-2

Surf. Elev. 777.9 ft. Hammer Drop 30 in. Rock Core Dia. -- in. Engineer LJC

Date Started 1/14/09 Pipe Size O.D. 2 in. Boring Method 3-1/4" HSA Date Completed 1/14/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUNDWATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER 16.5 hrs. Dry ft.
BACKFILLED 16.5 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING #: 14

PROJECT: Geotechnical Exploration, Advanced Treatment GAC-FTTP, Ft. Thomas, Kentucky JOB #: 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH (feet)	DEPTH SCALE (feet)	SAMPLE Cond	Blows/6"	No.	Type	Rec. (Inches)
777.3	SURFACE	0.3						
777.0	ASPHALT PAVEMENT			I	7/50/5"	1	DS	5
773.3	Mixed brown moist medium stiff FILL, silty clay, limestone and shale gravel, trace asphaltic concrete pieces.	4.0		I	7/9/9	2	DS	7
770.3	Mixed brown and gray moist loose FILL, fine to medium coarse sand, trace limestone gravel.	7.0	5	I	5/2/2	3	DS	6
	Bottom of test boring at 7.0 feet. Note: Test boring terminated due to presence of underground utilities.		10 15 20 25					

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 8 in. Foreman JS / TD-2

Surf. Elev. 777.3 ft. Hammer Drop 30 in. Rock Core Dia. -- in. Engineer LJC

Date Started 1/14/09 Pipe Size O.D. 2 in. Boring Method 3-1/4" HSA Date Completed 1/14/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUNDWATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER 15.5 hrs. Dry ft.
BACKFILLED 15.5 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

CIVIL ENGINEERS

G. J. Thelen & Associates, Inc.

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LOG OF TEST BORING

CLIENT Kenton County Water District — BORING # 4

PROJECT Geotechnical Exploration, Ft. Thomas Water Treatment Plant, Ft. Thomas, JOB # 87343E

LOCATION OF BORING As shown on Drawing 87343E-1 /Kentucky

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec.
778.0	SURFACE	0.0						
773.5	Mixed brown slightly moist hard FILL, silty clay, shale, trace topsoil, limestone floaters, hairlike roots.			I	3/10/18	1	DS	10"
				I	9/8/7	2	DS	4"
771.7	Mixed brown and gray moist medium stiff FILL, silty clay and shale with limestone floaters. (CL)	4.5	5	I	5/6/4	3A 3B	DS	16"
771.0	Mixed olive brown, trace gray moist stiff FILL, shale.	6.3 7.0		I	16/18/21	4	DS	16"
768.5	Mixed brown and gray moist medium stiff FILL, shale and silty clay with limestone floaters.	9.5	10	I	3/15/25	5	DS	14"
766.0	Mixed brown to dark brown moist medium stiff to stiff FILL, silty clay and topsoil with hairlike roots.	12.0						
763.0	Mixed brown moist medium stiff FILL, clay, trace gravel, sand and limestone floaters.	15.0	15	I	9/6/7	6	DS	18"
761.5	Brown, trace gray moist very soft highly weathered SHALE and thinly bedded LIMESTONE (bedrock).	16.5		I	7/18/50 /6"	7	DS	14"
758.5	Brown to olive brown moist soft weathered SHALE and thinly bedded LIMESTONE (bedrock).	19.5	20	I	20/37/31	8A 8B	DS	16"
755.8	Olive brown and gray moist soft weathered SHALE and thinly bedded LIMESTONE (bedrock).	22.2		I	27/50/2"	9	DS	6"
				I	50/2"	10	DS	2"
	Bottom of test boring at 22.2 feet.		25					

Datum USGS — Surf. Elev. 778.0 Ft. — Date Started 9/7/87

Hammer Wt. 140 Lbs. — Hammer Drop 30 In. — Pipe Size O.D. 2 In.

Hole Diameter 5" — Rock Core Dia. — Boring Method CFA

Foreman MW — Engineer TWV — Date Completed 9/7/87

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLER TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None FT.
AT COMPLETION Dry FT.
AFTER HRS. FT.
BACKFILLED Immed. HRS.

BORING METHOD
HSA – Hollow Stem Augers
CFA – Continous Flight Augers
DC – Driving Casing
MD – Mud Drilling

*STANDARD PENETRATION TEST – DRIVING 2" OD SAMPLER 1' WITH 140 # HAMMER FALLING 30" COUNT MADE AT 6" INTERVALS

CIVIL ENGINEERS

G. J. Thelen & Associates, Inc.
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LOG OF TEST BORING

CLIENT Kenton County Water District — BORING # 203
PROJECT Geotechnical Exploration, Phase II Clarifier/Flocculator, Ft. Thomas, — JOB # 89079E
LOCATION OF BORING As shown on Drawing 89079E-1 /Kentucky

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Re-
779.9	SURFACE							
778.9	Brown moist stiff FILL, silty clay and shale with limestone floaters.	1.0		I	2/4/50/5"	1	DS	10'
				X		2	RC	6"
776.9	SANDSTONE LINER.	3.0						
775.4	Brown moist medium dense FILL, fine to medium sand and gravel.	4.5	5	D	16/10/9	3	RC	12"
772.9	Mixed brown moist medium stiff FILL, silty clay and clay.	7.0		I	2/3/4	4	DS	18"
770.4	Mixed brown moist medium stiff FILL, clay and shale with limestone floaters.	9.5		I	5/7/10	5	DS	16"
767.9	Mixed brown moist stiff FILL, shale with limestone floaters.	12.0	10	I	5/45/32	6	DS	18
756.4	Olive brown and brown, trace gray moist soft weathered SHALE and thinly bedded LIMESTONE (bedrock).			I	50/4"	7	DS	4"
754.5	Gray moist soft SHALE and thinly bedded LIMESTONE (bedrock).		15	I	50/5"	8	DS	3"
	Refusal and bottom of test boring at 25.4 feet.			I	50/3"	9	DS	2"
	* Backfilled by dozer before final water reading made.	23.5	20	I	50/6"	10	DS	6"
		25.4		I	50/6"	11	DS	6"
			25	I	50/4"	12	DS	4"

Datum USGS — Hammer Wt. 140 Lbs. — Hole Diameter 5" — Foreman MW
Surf. Elev. 779.9 Ft. — Hammer Drop 30 In. — Rock Core Dia. — Engineer TWV
Date Started 4/14/89 — Pipe Size O.D.2 In. — Boring Method CFA — Date Completed 4/14/89

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLER TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None FT.
AT COMPLETION Dry FT.
AFTER 24 HRS. * FT.
BACKFILLED ____ HRS.

BORING METHOD
HSA – Hollow Stem Augers
CFA – Continous Flight Augers
DC – Driving Casing
MD – Mud Drilling

*STANDARD PENETRATION TEST – DRIVING 2" OD SAMPLER 1' WITH 140 #. HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

CIVIL ENGINEERS

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LOG OF TEST BORING

CLIENT Kenton County Water District BORING # 204

PROJECT Geotechnical Exploration, Phase II Clarifier/Flocculator, Ft. Thomas, JOB # 89079E

LOCATION OF BORING As shown on Drawing 89079E-1 /Kentucky

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec.
778.0	SURFACE							
	Mixed dark brown and brown moist medium stiff FILL, topsoil, trace shale and limestone floaters.	1.3		I	2/3/5	1	DS	13"
776.7								
	Mixed brown moist stiff FILL, silty clay, clay and shale with limestone floaters.	4.5		I	15/21/7	2	DS	9"
773.5			5					
	Mixed brown moist medium stiff to soft FILL, shale and silty clay, trace limestone floaters.			I	7/8/28	3	DS	16"
768.5				I	3/2/5	4	DS	16"
	SANDSTONE LINER.	9.5						
767.5		10.5	10	D		5	CA	
	Mixed brown moist soft to medium stiff FILL, clay with shale fragments, limestone floaters and wet sand and gravel.			I	13/10/7	6	DS	16"
763.5		14.5	15					
	Brown, trace olive brown and gray moist very soft highly weathered SHALE and thinly bedded LIMESTONE (bedrock).			I	50/25/2"	7	DS	8"
756.0				I	25/50/6"	8	DS	12"
	Brown to olive brown and gray moist soft weathered SHALE and thinly bedded LIMESTONE (bedrock).		20		Note:Scale Change			
751.0		22.0		I	50/6"	9	DS	6"
	Gray moist soft SHALE and thinly bedded LIMESTONE (bedrock).			I	50/6"	10	DS	6"
750.0		27.0	25	I	50/6"	11	DS	6"
		28.0		I	50/6"	12	DS	6"
	Refusal and bottom of test boring at 28.0 feet.		30					
			35					

Datum USGS | Hammer Wt. 140 Lbs. | Hole Diameter 5" | Foreman JM

Surf. Elev. 778.0 Ft. | Hammer Drop 30 In. | Rock Core Dia. | Engineer TWV

Date Started 4/20/89 | Pipe Size O.D.2 In. | Boring Method CFA | Date Completed 4/20/89

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLER TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED 11.0 FT.
AT COMPLETION Dry FT.
AFTER 7 HRS. Dry FT.
BACKFILLED 7 HRS.

BORING METHOD
HSA – Hollow Stem Augers
CFA – Continous Flight Augers
DC – Driving Casing
MD – Mud Drilling

CIVIL ENGINEERS

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LOG OF TEST BORING

CLIENT Kenton County Water District BORING # 301
PROJECT Geotechnical Exploration, Proposed Chlorine Building, Ft. Thomas Treat- JOB # 89079E
LOCATION OF BORING As shown on Drawing 89079E-3 / ment Plant, Ft. Thomas, Kentucky

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Re
779.4	SURFACE	0.3						
779.1	FILL, gravel.	2.0		I	6/8/12	1	DS	16"
777.4	Mixed brown moist very stiff FILL, silty clay, trace topsoil and limestone fragments.	4.5		I	18/17/19	2	DS	15"
774.9	Mixed brown slightly moist to moist very stiff FILL, silty clay with brown shale fragments.	8.5	5	I	7/5/9	3	DS	14"
770.9	Mixed brown and gray slightly moist to moist very stiff to stiff FILL, silty clay and shale with limestone floaters.	10.0		I	8/35/6"	4	DS	12"
769.4	SANDSTONE Liner.	10.5	10	I	25/9/12	5A 5B	DS	16"
768.9	Brown moist very dense FILL, silty fine to coarse sand and gravel.	14.0		I	8/9/12	6	DS	15'
765.4	Brown moist very soft highly weathered SHALE and thinly bedded LIMESTONE with clay seams (bedrock).		15	I	20/30/41	7	DS	18"
758.4	Brown moist soft weathered SHALE and thinly bedded LIMESTONE (bedrock).	21.0	20	I	41/6"	8	DS	6'
				I	25/50/6"	9	DS	12'
	Bottom of test boring at 21.0 feet.							
	Note: A Shelby tube sample was obtained in an offset hole from 1.0 to 2.0 feet. Recovery was 8 inches.		25					

Datum USGS | Hammer Wt. 140 Lbs. | Hole Diameter 5" | Foreman JM
Surf. Elev. 779.4 Ft. | Hammer Drop 30 In. | Rock Core Dia. | Engineer TWV
Date Started 5/26/89 | Pipe Size O.D.2 In. | Boring Method CFA | Date Completed 5/26/89

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLER TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None FT.
AT COMPLETION Dry FT.
AFTER HRS. FT.
BACKFILLED Immed. HRS.

BORING METHOD
HSA – Hollow Stem Augers
CFA – Continous Flight Augers
DC – Driving Casing
MD – Mud Drilling

CIVIL ENGINEERS

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LOG OF TEST BORING

CLIENT: Northern Kentucky Water Service District BORING # 1

PROJECT: Geotechnical Exploration, Laboratory Building, Ft. Thomas, Kentucky JOB # 980640E

LOCATION OF BORING: As shown on Drawing 980640E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. Inches
769.8	SURFACE	0.5						
769.3	TOPSOIL	2.3		D	10/14/21	1A 1B	DS	13
767.5	Mixed brown dry very stiff FILL, silty clay with limestone fragments and floaters.	4.5		I	4/7/9	2	DS	7
765.3	Mixed brown moist soft to medium stiff FILL, silty clay and shale with limestone fragments and floaters.		5	I	30/50/6"	3	DS	12
	Brown moist very soft highly weathered SHALE and thinly bedded LIMESTONE (bedrock).			I	35/50/6"	4	DS	12
756.8		13.0	10	I	50/6"	5	DS	6
754.3	Olive brown, trace gray moist soft weathered SHALE and thinly bedded LIMESTONE (bedrock).	15.5		I	38/50/6"	6	DS	12
	Bottom of test boring at 15.5		15	I	50/6"	7	DS	6
			20					
			25					

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman JM

Surf. Elev. 769.8 ft. Hammer Drop 30 in. Rock Core Dia. in. Engineer TWV/JSN

Date Started 9/11/98 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 9/11/98

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLE TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED 2.5 ft.
AT COMPLETION Dry ft.
AFTER 24 hrs. Dry ft.
BACKFILLED 24 hrs.

BORING METHOD
HSA– HOLLOW STEM AUGERS
CFA– CONTINUOUS FLIGHT AUGERS
DC – DRIVING CASING
MD – MUD DRILLING

STANDARD PENETRATION TEST – DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

CIVIL ENGINEERS

G. J. Thelen & Associates, Inc.

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LOG OF TEST BORING

CLIENT: Northern Kentucky Water Service District — BORING # 2

PROJECT: Geotechnical Exploration, Laboratory Building, Ft. Thomas, Kentucky — JOB # 980640E

LOCATION OF BORING: As shown on Drawing 980640E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. Inches
767.6	SURFACE	0.4						
767.2	TOPSOIL	2.0		D	10/30/6"	1A 1B	DS	10
765.6	Mixed brown and gray dry dense FILL, limestone fragments, some shale.			I	22/6"	2	DS	6
	Brown moist very soft highly weathered SHALE and thinly bedded LIMESTONE (bedrock).		5	I	30/6"	3	DS	6
				I	50/5"	4	DS	5
			10	I	35/30/3"	5	DS	9
753.6		14.0		I	50/3"	6	DS	3
752.1	Brown to olive brown, trace gray moist soft weathered SHALE and thinly bedded LIMESTONE (bedrock).	15.5	15	I	50/6"	7	DS	6
	Bottom of test boring at 15.5 feet.		20					
			25					

Datum MSL — Hammer Wt. 140 lbs. — Hole Diameter 5 in. — Foreman JM

Surf. Elev. 767.2 ft. — Hammer Drop 30 in. — Rock Core Dia. ____ in. — Engineer TWV/JSN

Date Started 9/11/98 — Pipe Size O.D. 2 in. — Boring Method CFA — Date Completed 9/11/98

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLE TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER 24 hrs. Dry ft.
BACKFILLED 24 hrs.

BORING METHOD
HSA– HOLLOW STEM AUGERS
CFA– CONTINUOUS FLIGHT AUGERS
DC – DRIVING CASING
MD – MUD DRILLING

STANDARD PENETRATION TEST – DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

CIVIL ENGINEERS

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LOG OF TEST BORING

CLIENT: Northern Kentucky Water Service District BORING # 3

PROJECT: Geotechnical Exploration, Laboratory Building, Ft. Thomas, Kentucky JOB # 980640E

LOCATION OF BORING: As shown on Drawing 980640E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. Inches
781.4	SURFACE	0.5						
780.9	TOPSOIL	1.5		D	7/8/8	1A 1B	DS	14
779.9	Mixed brown dry stiff FILL, silty clay and shale with limestone fragments and floaters.	4.5		I	7/14/17	2	DS	10
776.9	Brown slightly moist, very stiff CLAY with limestone fragments and floaters.		5	I	35/45/6"	3	DS	12
	Brown moist very soft highly weathered SHALE and thinly bedded LIMESTONE (bedrock).			I	50/6"	4	DS	6
			10	I	30/3"	5	DS	3
				I	50/4"	6	DS	4
			15	I	50/6"	7	DS	6
				I	50/5"	8	DS	5
			20	I	35/50/6"	9	DS	12
758.4		23.0						
	Brown to olive brown moist soft weathered SHALE and thinly bedded LIMESTONE (bedrock).	25.3	25					
756.1				I	50/3"	10	DS	3
	Bottom of test boring at 25.3 feet.							

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman JM

Surf. Elev. 781.4 ft. Hammer Drop 30 in. Rock Core Dia. in. Engineer TWV/JSN

Date Started 9/12/98 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 9/12/98

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLE TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER 5 hrs. Dry ft.
BACKFILLED 5 hrs.

BORING METHOD
HSA– HOLLOW STEM AUGERS
CFA– CONTINUOUS FLIGHT AUGERS
DC – DRIVING CASING
MD – MUD DRILLING

STANDARD PENETRATION TEST – DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

CIVIL ENGINEERS

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LOG OF TEST BORING

CLIENT: Northern Kentucky Water Service District BORING # 4

PROJECT: Geotechnical Exploration, Laboratory Building, Ft. Thomas, Kentucky JOB # 980640E

LOCATION OF BORING: As shown on Drawing 980640E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. Inches
783.1	SURFACE	0.0						
		1.0		D	8/15/40	1A 1B	DS	14
782.1	Light brown, dry very stiff SILTY CLAY with limestone fragments, trace hairlike roots.	2.0						
				I	50/6"	2	DS	6
781.1	Brown dry very soft highly weathered SHALE and thinly bedded LIMESTONE (bedrock).		5	D	50/3"	3	DS	3
				I	50/5"	4	DS	5
773.1	Brown moist very soft highly weathered SHALE and thinly bedded LIMESTONE (bedrock).	10.0	10	I	50/5"	5	DS	5
				I	25/30/2"	6	DS	8
	Brown to olive brown, trace gray moist soft weathered SHALE and thinly bedded LIMESTONE (bedrock).		15	I	50/6"	7	DS	6
				I	50/6"	8	DS	6
			20	I	35/50/3"	9	DS	9
757.6		25.5	25					
				I	50/6"	10	DS	6
	Bottom of test boring at 25.5 feet.							

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman JM

Surf. Elev. 783.1 ft. Hammer Drop 30 in. Rock Core Dia. in. Engineer TWV/JSN

Date Started 9\12\98 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 9/12/98

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLE TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED 15.3 ft.
AT COMPLETION Dry ft.
AFTER 7.5 hrs. Dry ft.
BACKFILLED 7.5 hrs.

BORING METHOD
HSA– HOLLOW STEM AUGERS
CFA– CONTINUOUS FLIGHT AUGERS
DC – DRIVING CASING
MD – MUD DRILLING

STANDARD PENETRATION TEST – DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

CIVIL ENGINEERS

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LOG OF TEST BORING

CLIENT: Northern Kentucky Water Service District — BORING # 5

PROJECT: Geotechnical Exploration, Laboratory Building, Ft. Thomas, Kentucky — JOB # 980640E

LOCATION OF BORING: As shown on Drawing 980640E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. Inches
770.7	SURFACE	0.3						
770.4	TOPSOIL	2.5		I	9/15/15/5"	1	DS	16
768.2	Mixed brown dry very stiff to hard FILL, clay and shale with limestone fragments and floaters.	3.8		I	9/11/12	2A 2B	DS	14
766.9	Mixed dark gray to bluish gray moist medium stiff FILL, topsoil and clay with limestone fragments.(CH)	5.5	5	I	50/6"	3	DS	6
765.2	Brown moist very soft highly weathered SHALE and thinly bedded LIMESTONE (bedrock).		10					
	Bottom of test boring at 5.5 feet.		15					
			20					
			25					

Datum MSL — Hammer Wt. 140 lbs. — Hole Diameter 5 in. — Foreman JM

Surf. Elev. 770.7 ft. — Hammer Drop 30 in. — Rock Core Dia. ____ in. — Engineer TWV/JSN

Date Started 9/12/98 — Pipe Size O.D. 2 in. — Boring Method CFA — Date Completed 9/12/98

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLE TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER ____ hrs. ____ ft.
BACKFILLED Immed. hrs.

BORING METHOD
HSA– HOLLOW STEM AUGERS
CFA– CONTINUOUS FLIGHT AUGERS
DC – DRIVING CASING
MD – MUD DRILLING

STANDARD PENETRATION TEST – DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: Northern Kentucky Water Service District BORING # 6

PROJECT: Geotechnical Exploration, Laboratory Building, Ft. Thomas, Kentucky JOB # 980640E

LOCATION OF BORING: As shown on Drawing 980640E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. Inches
776.6	SURFACE	0.5						
776.1	TOPSOIL	2.0		I	6/9/9	1A 1B	DS	18
774.6	Mixed brown dry very stiff FILL, silty clay with limestone fragments, concrete fragments, trace gravel.	6.0	5	I	50/6"	2	DS	6
770.6	Brown moist very soft highly weathered SHALE and thinly bedded LIMESTONE (bedrock).			I	28/50/6"	3	DS	12
	Bottom of test boring at 6.0 feet.		10 15 20 25					

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman JM

Surf. Elev. 776.6 ft. Hammer Drop 30 in. Rock Core Dia. in. Engineer TWV/JSN

Date Started 9/12/98 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 9/12/98

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLE TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER 1/2 hrs. Dry ft.
BACKFILLED 1/2 hrs.

BORING METHOD
HSA– HOLLOW STEM AUGERS
CFA– CONTINUOUS FLIGHT AUGERS
DC – DRIVING CASING
MD – MUD DRILLING

STANDARD PENETRATION TEST – DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: Northern Kentucky Water Service District BORING # 7

PROJECT: Geotechnical Exploration, Laboratory Building, Ft. Thomas, Kentucky JOB # 980640E

LOCATION OF BORING: As shown on Drawing 980640E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. Inches
783.3	SURFACE	0.0						
782.5	TOPSOIL	0.8		I	3/5/6	1A 1B	DS	16
781.3	Mixed brown moist stiff FILL, silty clay, trace roots	2.0						
779.8	Brown moist very soft highly weathered SHALE and thinly bedded LIMESTONE (bedrock).	3.5		I	25/50/6"	2	DS	12
	Bottom of test boring at 3.5 feet.		5 10 15 20 25					

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman JM

Surf. Elev. 783.3 ft. Hammer Drop 30 in. Rock Core Dia. in. Engineer TWV/JSN

Date Started 9/12/98 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 9/12/98

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLE TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER 2 hrs. Dry ft.
BACKFILLED 2 hrs.

BORING METHOD
HSA– HOLLOW STEM AUGERS
CFA– CONTINUOUS FLIGHT AUGERS
DC – DRIVING CASING
MD – MUD DRILLING

STANDARD PENETRATION TEST – DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: Northern Kentucky Water Service District BORING # 8

PROJECT: Geotechnical Exploration, Laboratory Building, Ft. Thomas, Kentucky JOB # 980640E

LOCATION OF BORING: As shown on Drawing 980640E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. Inches
779.1	SURFACE	0.0						
	Light brown, dry very stiff FILL, topsoil and silty clay with roots and gravel (fill).	0.7		I	9/16/21	1A 1B	DS	14
778.4		2.0						
	Brown dry very stiff SILTY CLAY with shale fragments, trace hairlike roots.	4.0		I	26/18/25	2	DS	13
777.1		5.5	5					
	Brown moist stiff SILTY CLAY with bedding planes and limestone floaters. (CL)			I	35/6"	3	DS	6
775.1								
	Brown moist very soft highly weathered SHALE and thinly bedded LIMESTONE (bedrock).		10					
773.6								
	Bottom of test boring at 5.5 feet.		15					
			20					
			25					

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman JM

Surf. Elev. 779.1 ft. Hammer Drop 30 in. Rock Core Dia. in. Engineer TWV/JSN

Date Started 9/12/98 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 9/12/98

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLE TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER 1 hrs. Dry ft.
BACKFILLED 1 hrs.

BORING METHOD
HSA– HOLLOW STEM AUGERS
CFA– CONTINUOUS FLIGHT AUGERS
DC – DRIVING CASING
MD – MUD DRILLING

STANDARD PENETRATION TEST – DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: Northern Kentucky Water Service District BORING # 9

PROJECT: Geotechnical Exploration, Laboratory Building, Ft. Thomas, Kentucky JOB # 980640E

LOCATION OF BORING: As shown on Drawing 980640E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. Inches
783.7	SURFACE	0.5						
783.2	TOPSOIL	1.3		I	8/10/25	1A 1B 1C	DS	18
782.4	Mixed brown and gray dry stiff FILL, silty clay with limestone fragments.	3.0		I	50/6"	2	DS	6
780.7	Brown moist very soft highly weathered SHALE and thinly bedded LIMESTONE (bedrock).							
	Bottom of test boring at 3.0 feet.							

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman JM

Surf. Elev. 783.7 ft. Hammer Drop 30 in. Rock Core Dia. in. Engineer TWV/JSN

Date Started 9/12/98 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 9/12/98

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLE TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER 1.5 hrs. Dry ft.
BACKFILLED 1.5 hrs.

BORING METHOD
HSA– HOLLOW STEM AUGERS
CFA– CONTINUOUS FLIGHT AUGERS
DC – DRIVING CASING
MD – MUD DRILLING

STANDARD PENETRATION TEST – DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: Northern Kentucky Water Service District BORING # 102

PROJECT: Geotechnical Exploration, Proposed Sodium Hypochlorite Building, Ft. Thomas, Ky. JOB # 990146E

LOCATION OF BORING: As shown on Drawing 990146E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. Inches
777.8	SURFACE	0.3						
		0.9						
777.5	ASPHALT.			I	9/6/8	1A 1B	DS	15
				I	5/7/25	2	DS	16
776.9	BASE, dense graded aggregate.		5	I	6/7/5	3	DS	13
				U		4	PT	7
	Mixed brown and gray moist medium stiff to stiff FILL, silty clay and pulverized shale with intact shale and limestone fragments and			I	35/5"	5	DS	2
			10	U		6	PT	7
760.3	floaters, trace sand (CL).			I	50/6"	7	DS	3
				I	10/11/8	8	DS	4
	Brown and gray wet very dense FILL, clayey sand and gravel with pieces of crushed limestone (possible remnant of old reservoir		15	I	19/21/11	9	DS	14
759.3	liner).	17.5						
		18.5		I	25/50/6"	10	DS	6
	Brown moist very soft highly weathered SHALE and thinly bedded LIMESTONE		20					
755.8	(bedrock).			I	30/50/6"	11	DS	12
	Olive brown, trace gray moist soft weathered SHALE and thinly bedded LIMESTONE	22.0						
748.3	(bedrock).			I	40/25/2"	12	DS	8
					NOTE: Scale Change			
	Gray moist soft SHALE and thinly bedded		25	I	50/5"	13	DS	5
747.3	LIMESTONE (bedrock).	29.5		I	50/5"	14	DS	5
	Split spoon refusal and bottom of test boring at 30.5 feet.	30.5	30	I	50/5"	15	DS	5

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman JM

Surf. Elev. 777.8 ft. Hammer Drop 30 in. Rock Core Dia. in. Engineer TWV

Date Started 4/10/99 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 4/10/99

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLE TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED 17.5 ft.
AT COMPLETION Dry ft.
AFTER hrs. ft.
BACKFILLED Immed. hrs.

BORING METHOD
HSA– HOLLOW STEM AUGERS
CFA– CONTINUOUS FLIGHT AUGERS
DC – DRIVING CASING
MD – MUD DRILLING

STANDARD PENETRATION TEST – DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: Northern Kentucky Water Service District BORING # 103

PROJECT: Geotechnical Exploration, Proposed Sodium Hypochlorite Building, Ft. Thomas, Ky. JOB # 990146E

LOCATION OF BORING: As shown on Drawing 990146E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. Inches
778.8	SURFACE	0.3						
		0.8		D		1	CA	
778.5	ASPHALT.			I	9/35/4"	2	DS	6
	BASE, crushed limestone.			U		3	PT	10
778.0			5	I	10/19/9	4	DS	14
				U		5	PT	6
	Mixed brown, trace gray moist, locally slightly moist stiff FILL, silty clay and pulverized shale with intact shale and limestone fragments and limestone floaters.			I	7/25/1"	6	DS	2
			10	I	7/14/21	7	DS	6
766.8		12.0						
	Mixed brown moist soft FILL, silty clay and pulverized shale with limestone fragments and floaters (CL).			I	2/15/6"	8	DS	6
		14.5	15					
764.3				I	3/7/12	9	DS	13
	Mixed brown, trace gray moist stiff FILL, silty clay, pulverized shale and unpulverized shale with limestone floaters.			I	4/7/11	10	DS	15
758.3								
	SANDSTONE LINER.	20.5	20					
757.8		21.0		I	25/5"	11	DS	1.5
	Brown moist soft weathered SHALE and thinly bedded LIMESTONE (bedrock).			I	15/30/45/3"	12	DS	12
753.5		25.3	25					
	Bottom of test boring at 25.3 feet.			I	50/3"	13	DS	2

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman JM

Surf. Elev. 778.8 ft. Hammer Drop 30 in. Rock Core Dia. ____ in. Engineer TWV

Date Started 4/10/99 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 4/10/99

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLE TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER ____ hrs. ____ ft.
BACKFILLED Immed. hrs.

BORING METHOD
HSA– HOLLOW STEM AUGERS
CFA– CONTINUOUS FLIGHT AUGERS
DC – DRIVING CASING
MD – MUD DRILLING

STANDARD PENETRATION TEST – DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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• 1398 Cox Avenue, Erlanger, Kentucky 41018-1002 / 859-746-9400 / Fax 859-746-9408
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SOIL CLASSIFICATION SHEET

NON COHESIVE SOILS
(Silt, Sand, Gravel and Combinations)

Density

Very Loose	- 5 blows/ft. or less
Loose	- 6 to 10 blows/ft.
Medium Dense	- 11 to 30 blows/ft.
Dense	- 31 to 50 blows/ft.
Very Dense	- 51 blows/ft. or more

Relative Properties

Descriptive Term	Percent
Trace	1 – 10
Little	11 – 20
Some	21 – 35
And	36 – 50

Particle Size Identification

Boulders	- 8 inch diameter or more	
Cobbles	- 3 to 8 inch diameter	
Gravel	- Coarse	- 3/4 to 3 inches
	- Fine	- 3/16 to 3/4 inches
Sand	- Coarse	- 2mm to 5mm (dia. of pencil lead)
	- Medium	- 0.45mm to 2mm (dia. of broom straw)
	- Fine	- 0.075mm to 0.45mm (dia. of human hair)
Silt		- 0.005mm to 0.075mm (Cannot see particles)

COHESIVE SOILS
(Clay, Silt and Combinations)

Consistency	Field Identification	Unconfined Compressive Strength (tons/sq. ft.)
Very Soft	Easily penetrated several inches by fist	Less than 0.25
Soft	Easily penetrated several inches by thumb	0.25 – 0.5
Medium Stiff	Can be penetrated several inches by thumb with moderate effort	0.5 – 1.0
Stiff	Readily indented by thumb but penetrated only with great effort	1.0 – 2.0
Very Stiff	Readily indented by thumbnail	2.0 – 4.0
Hard	Indented with difficulty by thumbnail	Over 4.0

Classification on logs are made by visual inspection.

Standard Penetration Test – Driving a 2.0" O.D., 1 3/8" I.D., sampler a distance of 1.0 foot into undisturbed soil with a 140 pound hammer free falling a distance of 30 inches. It is customary to drive the spoon 6 inches to seat into undisturbed soil, then perform the test. The number of hammer blows for seating the spoon and making the tests are recorded for each 6 inches of penetration on the drill log (Example – 6/8/9). The standard penetration test results can be obtained by adding the last two figures (i.e. 8+9=17 blows/ft.). Refusal is defined as greater than 50 blows for 6 inches or less penetration.

Strata Changes – In the column "Soil Descriptions" on the drill log, the horizontal lines represent strata changes. A solid line (————) represents an actually observed change; a dashed line (— — — —) represents an estimated change.

Groundwater observations were made at the times indicated. Porosity of soil strata, weather conditions, site topography, etc., may cause changes in the water levels indicated on the logs.

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Rock Weathering and Strength Classification Sheet

Rock Weathering

Descriptions	Field Identification
Unweathered	No visible sign of rock material weathering, perhaps slight discoloration on major discontinuity surfaces.
Slightly Weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than it its fresh condition.
Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.
Highly to Extremely Weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.
Residual Soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

Rock Strength

Descriptions	Field Identification	Strength (psi*)
Extremely Weak	Indented by thumbnail	40-150
Very Weak	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife.	150-700
Weak	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer.	700-4000
Medium Strong	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with a single blow of a geological hammer.	4000-7000
Strong	Specimen requires more than one blow of a geological hammer to fracture.	7000-15,000
Very Strong	Specimen requires many blows with a geological hammer to fracture.	15,000-36,000
Extremely Strong	Specimen can only be chipped with geological hammer.	>36,000

***Approximate range of uniaxial compressive strength**

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CASE NO: 2010-00093

CONTAINS

LARGE OR OVERSIZED

MAP(S)

RECEIVED ON: February 26, 2010

GEOTECHNICAL EXPLORATION

ADVANCED TREATMENT, GAC

ADDITIONAL SITE IMPROVEMENTS

FT. THOMAS, KENTUCKY

Prepared for: **CH2M Hill, Inc.**

Thelen Project No.: **080978E**

THELEN ASSOCIATES, INC.

www.thelenassoc.com

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November 2, 2009

CH2M Hill
300 E. Business Way, Suite 400
Cincinnati, Ohio 45241

Attn: Mr. Nicholas Winnike, P.E.

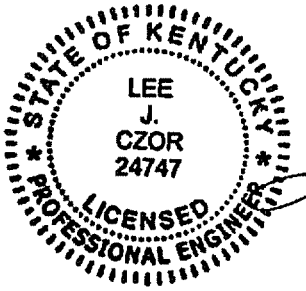
Re: Geotechnical Exploration
Advanced Treatment, GAC
Additional Site Improvements
Ft. Thomas, Kentucky

Ladies and Gentlemen:

We are pleased to submit to you the attached Report of Geotechnical Exploration for the above referenced project. The report includes a description of the proposed project site, a description of the test boring and laboratory testing programs, as well as conclusions and geotechnical recommendations. The report was prepared in accordance with our Proposal-Agreement K29149 dated July 31, 2009 and our Revised Proposal-Agreement No. K29163, dated August 14, 2009.

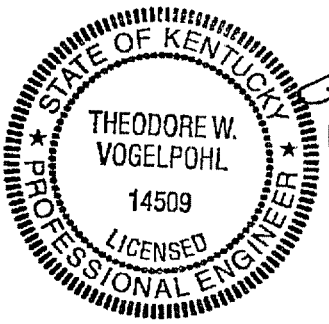
We have included in the Appendix to this report a reprint of "Important Information About your Geotechnical Engineering Report" published by ASFE, Professional Firms Practicing in the Geosciences, which our firm would like to introduce to you at this time.

We appreciate the opportunity to provide our geotechnical services for this project. Should you have any questions regarding our conclusions and recommendations, or if we may be of further assistance to you, please do not hesitate to contact us.



Respectfully submitted,
THELEN ASSOCIATES, INC.

Lee J. Czor, P.E.
Senior Geotechnical Engineer



Theodore W. Vogelpohl, P.E.
Principal Geotechnical Engineer

LJC/TWV:tmk
080978E

Copies submitted: 5 – Client
1 – HDR Engineering, Inc.
1 – Freeland Harris
1 – Northern Kentucky Water District

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November 2, 2009

GEOTECHNICAL EXPLORATION
ADVANCED TREATMENT, GAC
ADDITIONAL SITE IMPROVEMENTS
FT. THOMAS, KENTUCKY

1.0 INTRODUCTION

Presented in this report are the results of our geotechnical exploration for Additional Site Improvements proposed for the Advanced Treatment Granular Activated Carbon (GAC) project at the Northern Kentucky Water District (NKWD) Fort Thomas Treatment Plant. This additional work was conducted to supplement the information, analyses, and recommendations presented in the previous Report of Geotechnical Exploration for the Advanced Treatment GAC Building dated July 22, 2009. The additional geotechnical work included test borings, laboratory testing, engineering analysis, and preparation of this report for the proposed additional site improvements.

2.0 PROJECT DESCRIPTION

The NKWD Fort Thomas Treatment Plant is located near the intersection of US 27 (Alexandria Pike) with Grandview Avenue in Fort Thomas, Kentucky. Our understanding of the proposed site improvements is based on a site visit, conversations with Mr. Nicholas Winnike, PE of CH2M Hill, a sketch of structure locations provided by HDR, Inc. (HDR) of Lexington, Kentucky on July 30, 2009 (updated on September 28, 2009), and on our review of plans and drawings posted to the CH2M Hill Sharepoint site on September 2, 2009. The proposed additional improvements associated with the treatment plant upgrade include: 1) the entrance road will be widened between the existing security gate and the lower parking lot servicing the existing Laboratory

Building; 2) a new retaining wall, roughly 130 feet in length, will be considered along the slope between the northwest corner of the existing Filter Building and existing round Clearwell structure; 3) a new pipeline discharge headwall will be constructed on the south bank of the south reservoir where the EQ Pump Station force main terminates; 4) several valve vault/splitter box structures will be constructed at various locations on the site; and 5) due to the expected increase in construction related vehicle traffic through the FTTP main gate entrance, it has been proposed that overflow traffic and some light construction traffic be allowed to use the north and south reservoir perimeter roads for access to the facility. The condition of the existing pavements and subgrade materials along this section of roadway will be evaluated for this purpose.

Specifically, the entrance road to the plant will be widened to accommodate additional traffic associated with construction of the plant improvements noted above. The widening will begin roughly 40 feet past the entrance gate and terminate at the parking lot servicing the lower Laboratory Building. The existing pavement will be widened a maximum of approximately 20 feet and is depicted on the General Site Plan provided by the Designer and shown on the Boring Plan Detail, Drawing 080978E-6, included in the Appendix to this report. The existing slope from the laboratory building to the existing drainage swale at the edge of the pavement has a maximum slope geometry of approximately 2.6 Horizontal to 1 Vertical (2.6H:1V). It is our understanding that a storm sewer system will be installed on the inside radius of the pavement to handle stormwater runoff that previously was directed to the swale. Cuts on the order of 3 feet will be required to achieve the proposed grade. The maximum proposed slope geometry will be about 2.7H:1V at the transition from the undisturbed existing slope to the cut area. The proposed slopes will become flatter as the entrance road approaches the lower Laboratory Building parking area.

A roughly 130 foot long retaining wall was originally proposed to be constructed on the hillside between the existing Filter Building and the round Clearwell. Subsequent to the field exploration program, the wall was eliminated from the design. The current plan sketches provided by HDR indicate that a 36-inch diameter GAC Influent Pipe will be constructed along the hillside, however, no change in grade is indicated.

Three circular concrete valve vault structures will be constructed north of the existing Filter Building. The structures, noted as Valve Vaults 1 through 3, will be approximately 10, 8, and 8 feet in diameter with inverts at about elevations 762, 764, and 763 feet, respectively. Additionally, a structure roughly 14-feet square in plan dimension (shown as Valve Vault 4 on the Boring Plan) will be located about 15 feet south of the existing Filter Building with a finished floor at about elevation 759 feet. Also, a proposed Splitter Box, expected to be about 15 x 20 feet in plan dimension, will be located roughly 25 feet from the northwest corner of the proposed GAC Building, and will have a subgrade elevation of approximately 766.0 feet. These structures are identified on plan view sketches provided by HDR, dated September 28, 2009, and their locations are shown on the Boring Plan Detail, Drawing 080978E-6 included in the Appendix to this report.

The EQ Discharge Headwall Structure indicated above will contain a 24-inch diameter ductile iron discharge pipe and will be approximately 15 x 15 feet in plan area. It will be located on the south side of the South Reservoir about 200 feet from the reservoir earthen dam, and will bear at approximate elevation 795 feet.

Finally, the existing asphalt pavement perimeter road around the north and south reservoirs currently handles very limited traffic, on the order of one car or pickup truck per day. It has been proposed to allow passenger cars, light pickup trucks and potentially forklifts and/or front-end loaders to use this road as alternative access to the plant; or to a potential lay down area during construction of the plant facilities. Gated access points exist at the end of the loop roads for both the north and south reservoirs. The existing road is, excluding the areas across the earthen reservoir dams, roughly 4,700 feet in length and varies in width from about 11 to 12 feet. The current conditions of the pavement and subgrade have been evaluated to determine the potential damage caused by the increase in traffic. The North and South Reservoir Perimeter Roads are shown on the Boring Plan, Drawing 080978E-5 included in the Appendix to this report.

3.0 SITE TOPOGRAPHY, DEVELOPMENT HISTORY AND GEOLOGIC CONDITIONS

The project site is located within Campbell County in Northern Kentucky, which is part of the Outer Bluegrass Physiographic Region. Hilly, well-dissected upland areas and relatively steep-sided stream and river valleys characterize this area. The site generally drains to an unnamed creek branch across US 27, which empties into Three Mile Creek, which in turn drains into the Licking River about 1250 feet to the southwest.

The FTTP site is located in a filled drainage valley. The terraced hillside that will be the GAC Building location is on the south valley wall or slope, above the fill. The north valley wall or slope is obvious (topographically) opposite the GAC site, north of the Clearwell, Sodium Hypochlorite Building and North Clarifier/Flocculator No. 3. The original valley bottom extended from U.S. 27 eastward beneath the Filter Building, and then branched into two valleys northeastward and southeastward beneath the existing north and south reservoirs. Originally, a single, stone-lined reservoir was located in this valley below the existing Filter Building and Clarifiers/Flocculators No. 3 and No. 4. The dam for this reservoir was west of the Filter Building. As the treatment plant was expanded over the years, the two current reservoirs/dams were built in the branched valleys, the original reservoir and valley down to U.S. 27 were filled, and the existing structures were constructed. A reservoir access road runs along the perimeter of each reservoir with crossings along the crest of each earthen dam. The road consists of an asphalt pavement roughly 12 feet in width. The existing Filter Building is founded on footings bearing deep below the valley fill and the original reservoir liner. The Clearwell, Clarifiers/Flocculators No. 3 and No. 4, the Sodium Hypochlorite Building, the Chemical Building and the Lab Building are supported on combinations of spread footings bearing on bedrock and drilled shafts extending through valley fill to bedrock. We are not aware of any performance issues with the existing buildings.

Available geologic mapping (Geologic Map of Parts of the Newport and Withamsville Quadrangles, KY, USGS, 1973) indicates the project site is underlain by Upper Ordovician Age bedrock of the Fairview Formation. The bedrock is noted on the Mapping to consist of interbedded shale and limestone. The shale is noted on the Map

to comprise about 60 percent or more of the total and occurs in beds mostly less than ten inches thick. It is described on the Mapping as light bluish gray to medium gray (weathering dusky yellow to light olive gray), laminated to thinly bedded, calcareous, silty, and fossil poor. The limestone makes up 40 percent or less of the total, is described as medium gray, coarsely crystalline grained and fossil fragmental, in distinct beds generally less than eight inches thick, but locally as much as three feet thick. Structure contours drawn on the base of the Fairview Formation indicate relatively horizontal bedrock bedding, with a bedrock dip to the west of less than 0.5 percent. The shale and limestone percentages on the Map are averages over the entire formation thicknesses, and local variations from these average percentages do exist. No faults, landslide activity, or geologic hazards are noted on the Map within the immediate vicinity of the project site. Kentucky Geological Survey Karst Potential Mapping indicates that the limestone units in the vicinity of the project site have low to medium potential for development of karst features.

4.0 SUBSURFACE EXPLORATION

Thelen Associates, Inc. (Thelen) personnel carried out the fieldwork phase of this exploration between August 14, 2009 and August 25, 2009. Eighteen (18) test borings, numbered 1001 through 1018, were drilled at the locations shown on the Boring Plans, Drawings 080978E-5 and 080978E-6, in the Appendix to this report. The test borings were staked in the field by Thelen personnel, with the locations and surface elevations determined from existing benchmarks established by the Designer.

The test borings were advanced using track- and truck-mounted drill rigs advancing continuous flight and hollow stem augers. Standard Penetration Testing using split-spoon samplers was accomplished ahead of the augers following the procedures outlined in ASTM D1586. In addition, one (1) undisturbed sample was obtained using a 3-inch O.D. thin walled, Shelby tube sampler hydraulically pushed into the soils using the drill rig per ASTM D1587. Thin walled asphalt core samples were obtained using a 6-inch hollow bit advanced using the drill rig.

As each test boring was advanced, the Drilling Technician kept a log of the subsurface profile noting the pavement, soil and bedrock types and stratifications, groundwater, penetration test results, and other pertinent data. Particular attention was given to the textures, colors, moisture contents, and consistencies of the materials encountered. Prior to transportation to our materials testing facility, representative portions of the split-spoon samples were placed in labeled glass jars, the ends of the Shelby tube were capped and taped to preserve the in situ moisture content and density of the undisturbed sample, and the asphalt core samples were labeled and wrapped in plastic. The Logs of Test Borings are included in the Appendix to this report.

Groundwater measurements were made in the boreholes during drilling, at the completion of drilling, and at time intervals following the completion of drilling. These groundwater measurements are noted at the bottoms of the test boring logs.

Test Borings advanced during previous geotechnical explorations performed by Thelen in 1987, 1989, 1998, and 1999 at various locations on the plant site were used to provide additional information about the subsurface conditions. The locations of selected test borings from these previous explorations are shown on the Boring Plan Detail, Drawing 080978E-6, and logs of these test borings are included in the Appendix to this report.

5.0 LABORATORY TESTING AND REVIEW

The samples from the test borings were examined and visually classified in the laboratory by the Project Geotechnical Engineer. Representative samples were selected for natural moisture content determinations, Atterberg limits testing, and an unconfined compression test on soil. Soil classification identifications were developed in accordance with the Unified Soil Classification System (USCS). Thelen personnel performed laboratory testing in accordance with the applicable ASTM methods for soil testing. The results of the testing are included in the Tabulation of Laboratory Tests in the Appendix along with the unconfined compressive strength test form.

Final test boring logs were prepared by the Project Geotechnical Engineer on the basis of the visual classification in the laboratory, the laboratory test results and the field logs kept by the Drilling Technician. Copies of the final test boring logs made for this project are included in the Appendix with a Soil Classification Sheet, which describes the terms and symbols used on the boring logs. Copies of selected test boring logs from previous explorations made by Thelen at the FTTP are also provided in the Appendix.

The dashed lines on the test boring logs indicate an approximate change in soil or bedrock strata as estimated between samples. A solid line indicates a change in strata occurred within a sample where a more precise measurement could be made. The transitions between soil and bedrock types may be abrupt or gradual.

6.0 SUBSURFACE/SITE CONDITIONS

6.1 General

Based on our interpretation of the geologic mapping, the results of test borings and laboratory testing, and our previous experience in the immediate area, the FTTP site was developed by excavating the terraces on the surrounding hillsides, and filling the adjacent drainage valley below the existing Filter Building and the two existing reservoir dams. What remains on these terraced slopes are thin deposits of topsoil and reworked native clays and weathered bedrock (described as fill) over isolated thin deposits of undisturbed native clays and then the interbedded shale and limestone bedrock. What exists in the valley between the terraced slopes is relatively deep fill comprised of mixed clays and shales with limestone floaters, over thin native clay deposits and then the bedrock.

Test Borings were advanced in three areas to supplement existing subsurface information required to provide recommendations for the improvements noted in Section 2.0 of this report: 1) the pavement expansion from the Entrance Gate to the lower Laboratory Building parking lot; 2) the hillside between the existing Filter Building and the round Clearwell structure; and 3) the North and South Reservoir perimeter roadways.

6.2 Entrance Gate Pavement Expansion

Test Borings 1001 and 1002 were advanced between the Entrance Gate and the lower Parking Lot serving the existing Laboratory Building and are shown on the Boring Plan Detail, Drawing 080978E-6, included in the Appendix to this report. Test Boring 1001 was located within the roadway near the existing security gate. Asphalt overlying concrete was encountered below the ground surface in thicknesses of 6- and 7-inches, respectively. Fill material approximately 1.5 feet in thickness was encountered below the concrete and consisted of mixed brown, moist, loose, fine to coarse clayey sand, with trace gravel. Natural moisture content testing of one (1) jar sample of the fill material yielded a value of 14.7 percent.

A 4-inch layer of topsoil was encountered directly below the ground surface in Test Boring 1002, located near the toe of the grassy hillside below the existing Laboratory Building. Fill material approximately 1.7 feet in thickness was encountered below the topsoil and was described as mixed brown, moist, stiff, silty clay, with some limestone and shale fragments. Natural moisture content testing of one (1) jar sample yielded a moisture content value of 18.6 percent.

A bedrock formation consisting of a system of interbedded shale and limestone layers was encountered below the fill materials in both test borings. As previously noted, the bedrock is a system of Ordovician Aged shale and limestone, is relatively horizontally bedded, and correlates well with the Fairview Formation on the referenced mapping. Bedrock in the Northern Kentucky Area is typically characterized in three basic zones depending upon the degree of weathering. The uppermost zone is termed highly to moderately weathered interbedded shale and limestone, where the shale portion has virtually weathered to a brown silty clay or clay, yet possesses horizontally aligned bedding characteristics of the bedrock system and may contain clay seams. The intermediate zone is described as moderately to slightly weathered bedrock and is characterized by a shale component that is tougher, and generally at lower moisture contents than the shale in the highly weathered zone above. The upper and intermediate zones have weathered from the third commonly accepted zone; the gray, slightly weathered to unweathered, parent interbedded shale and limestone. The

limestone beds in all three zones are very strong and relatively unweathered compared to the shale. Because of variable weathering and erosion conditions, highly weathered and moderately weathered zones may or may not be locally present above the unweathered bedrock zone, and slightly weathered to unweathered zones may be underlain by highly to moderately weathered zones.

The top of the intermediate or moderately to slightly weathered bedrock zone was encountered in Test Borings 1001 and 1002 below the fill layer. Moisture content testing on three (3) jar samples from the shale portion of the bedrock yielded values of 9.9, 11.8 and 11.8 percent.

6.3 Hillside between Filter Building and Clearwell

Based on preliminary plans provided by the Designer at the time of the field exploration, Test Borings 1003 through 1005 were advanced in the general location of a proposed 130-foot long retaining wall, and are shown on the Boring Plan Detail, Drawing 080978E-6, included in the Appendix to this report. It is our understanding that subsequent to the field exploration program, the proposed retaining wall was removed from the design and the existing slope (with geometry approximately 2.5H:1V) will remain. The Boring Logs are included in the Appendix to this report.

A topsoil layer was encountered directly below the ground surface in Test Borings 1004 and 1005 in thicknesses of 4- and 6-inches, respectively. Fill materials were encountered below the topsoil in Test Borings 1003, 1004, and 1005 in thicknesses of approximately 43.0, 39.7, and 16.5 feet, respectively. The material generally consisted of mixed brown and gray, moist to very moist, soft to stiff silty clay with shale and limestone floaters and fragments. Zones of mixed brown and gray, wet, loose, coarse sand and gravel (pea gravel) were noted in Test Borings 1004 and 1005. Natural moisture content testing on fourteen (14) jar samples yielded values ranging from 10.5 percent to 24.6 percent, with an average value of about 19 percent. One undisturbed sample obtained between the depths of 3.0 to 5.0 feet in Test Boring 1004 classified as CL according to the USCS and exhibited a natural moisture content of 18.1 percent, a liquid limit (LL) of 45 percent, and a plasticity index (PI) of 19 percent. Unconfined

compressive strength testing of the sample yielded a strength value of 6,220 pounds per square foot (psf) and a natural dry density of 113.0 pounds per cubic foot (pcf).

An undisturbed soil material described as gray and blue-green, moist, medium stiff clay (lakebed clay) was encountered in Test Boring 1003 below the fill layer and above the top of the bedrock in a thickness of approximately 5.5 feet. One natural moisture content test yielded a value of 19.9 percent.

A native soil material, silty clay with shale fragments, was encountered below the fill material and above the top of bedrock in Test Boring 1005 in a thickness of approximately 2.5 feet. One natural moisture content test yielded a value of 16.6 percent.

The top of the intermediate or moderately to slightly weathered bedrock zone was encountered in Test Borings 1003 through 1005 at depths of approximately 48.5, 40.0, and 19.5 feet, respectively. Moisture content testing on three (3) jar samples from the shale portion of the bedrock yielded values of 31.4, 8.7, and 14.3 percent.

6.4 Valve Vaults/Splitter Box/EQ Discharge Headwall Structure

No additional test borings were advanced in the areas of Valve Vaults 1 through 3 for this exploration due to the presence of numerous existing utility pipelines and the availability of information from nearby test borings advanced during previous explorations. Test Boring 4 from a subsurface exploration performed in 1987 was located less than 20 feet to the north of the proposed Valve Vault 3 location. This information was used along with the information from Test Boring 1005 to provide an indication of the subsurface conditions at the noted valve vault locations. In general, the ground surface is underlain by topsoil and medium stiff to stiff silty clay fill material overlying the interbedded shale and limestone bedrock. As noted in the previous section of this report, the bedrock was noted to be approximately 19.5 feet below the ground surface (approximate El. 753.9) in Test Boring 1005. The bedrock was noted to be approximately 15.0 feet below the ground surface (approximate El. 763.0) at the Test Boring 4 location (Thelen Project No. 87343).

The location of Valve Vault 4 is between Test Boring 301, advanced during a geotechnical exploration for the proposed Chorine Building in 1989 (Thelen Project No. 89079), and Test Boring 13 advanced during the geotechnical exploration for the GAC Building in 2008. The information from these test borings indicates that the ground surface is underlain by silty clay or granular fill materials of variable consistency, overlying undisturbed native colluvial silty clay or interbedded shale and limestone bedrock. Remnants of the sandstone liner from the abandoned reservoir were detected at approximately 10.0 feet below ground surface in Test Boring 301. The bedrock surface was noted at approximately 10.5 feet below the ground surface (approximate El. 768.9) in Test Boring 301 and at approximately 24.0 feet below the ground surface (approximate El. 753.9) in Test Boring 13.

The proposed Splitter Box is located between Test Boring 204, advanced during the geotechnical exploration for the proposed Clarifier/Flocculator in 1989 (Thelen Project No. 89079E), and Test Boring 8 advanced during the geotechnical exploration for the GAC Building in 2008. Based on information from Test Borings 204 and 8, the bedrock surface varies from approximately 14.5 to 4.5 feet below the ground surface (approximate elevations 763.5 and 776.1), respectively. Medium stiff to stiff silty clay fill materials were encountered below the ground surface to the top of the interbedded shale and limestone bedrock. Remnants of the sandstone liner noted above were detected at approximately 9.5 feet below ground surface in Test Boring 204.

Test Boring 1007 was advanced within the asphalt roadway at the approximate location of the EQ Discharge Headwall Structure. The pavement and subsurface material encountered are discussed in Section 6.5 of this report. The interbedded shale and limestone bedrock surface was encountered in this boring at approximately 1.9 feet below ground surface (approximate El. 803.1).

6.5 North and South Reservoir Perimeter Roads

Test Borings 1006 through 1018 were advanced within the asphalt pavement along the perimeter road around the North and South Reservoirs and are depicted on the Boring Plan, Drawing 080978E-5, included in the Appendix to this report. These borings were

performed in order to determine the condition of the existing asphalt pavement and subgrade for the reservoir road. Six-inch diameter thin walled core samples of the asphalt pavement section were obtained at each test boring location.

The core samples obtained in Test Borings 1006 through 1018 ranged in thickness from approximately 2-inches (0.2 feet) to 8-inches (0.7 feet), with an average thickness of approximately 4 ½ -inches (0.4 feet). During the site reconnaissance at the project site, the roadway surface exhibited longitudinal cracking and displacement at several locations along the pavement edges. Moderate alligator and stress cracking was evident on the pavement surface along the entire alignment.

The pavement subgrade generally consisted of fill materials that were described as mixed brown, moist, medium stiff to very stiff, silty clay with shale and limestone fragments and occasional floaters. The pavement subgrade in Test Boring 1007 consisted of mixed brown, slightly moist, loose to medium dense sand and gravel. We interpret this material to be utility backfill from a nearby pipe pointed out by facility personnel during the drilling. Moisture content testing of seventeen (17) jar samples of the cohesive fill materials yielded results ranging from 5.9 to 25.1 percent, with an average moisture content of about 14 percent.

Medium stiff to very stiff undisturbed native soil materials or moderately to highly weathered interbedded shale and limestone bedrock were encountered below the fill in Test Borings 1012, 1015, and 1016 at depths of 0.8, 1.8, and 1.8 feet, respectively. The native soils were encountered directly below the asphalt pavement in Test Boring 1010. The native soils were generally described as brown, moist, silty clay with shale and limestone fragments. Moisture content testing on five (5) representative jar samples yielded results ranging from 19.5 to 28.1 percent, with an average moisture content value of about 24 percent.

The surface of the moderately to highly weathered interbedded shale and limestone bedrock was encountered below the fill in Test Borings 1006, 1007, and 1008 at depths

of 1.7, 1.9, and 1.3 feet, respectively. Moisture content testing on three (3) jar samples yielded moisture content values of 16.9, 18.7, and 19.2 percent.

7.0 GROUNDWATER

Based on our local experience, groundwater seepage can occur at the fill soil/native soil interface, at the native soil/bedrock interface, and along limestone layers within the bedrock. Groundwater was measured in test boring 1001 at 5.9 feet below ground surface during the drilling process, and at 4.8 feet approximately 23 hours after the completion of drilling. Additionally, groundwater was noted in Test Boring 1004 at approximately 30.0 feet below ground surface during drilling, 31.4 feet at the completion of drilling, and 29.5 feet about 29 hours after the completion of drilling. A consistent groundwater table was not identified within the test borings. In our opinion, isolated seepage zones were encountered, which is typical for the bedrock profile, and indicative of the groundwater springs that have periodically been noted by NKWD personnel. There may be seasonal fluctuations of the groundwater table based on temperatures and/or precipitation amounts. Individual groundwater readings can be found at the bottoms of the test boring logs in the Appendix to this report.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 General

Based upon the test borings, a visual examination of the samples, the laboratory tests, our understanding of the proposed construction, and our experience as Consulting Soil and Foundation Engineers in the Northern Kentucky Area, we have reached the conclusions and make the recommendations in this report.

If conditions are encountered in the field during construction that vary from the facts of this report, we recommend that our office be contacted immediately to review the changed conditions in the field and make appropriate recommendations.

The scope of our services did not include any environmental assessment or investigation for the presence or absence of wetlands or hazardous or toxic materials in the soil, bedrock, surface water, groundwater or air, on or below or around this site.

We have performed the test borings and laboratory tests for our evaluation of the site conditions and for the formulation of the conclusions and recommendations of this report. We assume no responsibility for the interpretation or extrapolation of the data by others.

The earthwork recommendations of this report presume that an Engineering Technician under the direction of a Registered Professional Engineer will monitor the earthwork continuously. We recommend that the Owner contract these services directly with Thelen Associates, Inc.

We recommend that a preconstruction meeting be held at the site with the Owner's representative(s), the Design Engineer, the Project Structural Engineer, the General Contractor, the Excavating Contractor, the Geotechnical Engineer and any other interested parties to review the scope and schedule of the proposed earthwork and foundation installation.

8.2 Entrance Gate Pavement Expansion

As noted previously, it is our understanding that cuts of up to about 3 feet will be required to achieve grade on the proposed slope from the laboratory building to the edge of the widened pavement. These excavations will extend through thin deposits of stiff to very stiff fill materials and into the moderately to slightly weathered interbedded shale and limestone bedrock. We anticipate that conventional track-mounted excavation equipment will be able to readily excavate the existing fill and bedrock materials in this area. Small fills of up to 1 foot will be required to achieve grade at the bottom of the slope closest to the entrance gate.

The proposed cut and fill areas in this area should be cleared of all existing trees and/or vegetation. The vegetation and heavy root system (and all topsoil) should be stripped. The vegetation should be wasted off site. The topsoil can be stockpiled for re-use in grassy or landscaped areas.

After clearing and stripping operations are complete, we recommend that areas to be considered for new pavements of any kind should be proofrolled with a heavily loaded piece of equipment under review of the Project Geotechnical Engineer or his representative. Any soft or yielding surfaces detected during the proofroll should be undercut to firm, non-yielding soils or bedrock. The bottom of all undercuts and other approved subgrade surfaces should then be compacted to at least 95 percent of the standard Proctor maximum dry density, ASTM D698, prior to filling.

The contract documents should be clear about payment to the Contractor regarding undercuts. If undercutting is not part of the lump sum base bid, then the contract should include the unit prices for those items, and arrangements should be made for documenting the volume of undercuts during construction.

The existing clean, clayey fill soils or moderately to highly weathered shale and limestone bedrock should be suitable for use as new compacted fills. If off-site borrow soils are to be used as a source of fill material, they should be reviewed by the Project Geotechnical Engineer or his representative prior to their use. All fill soils should be relatively free of topsoil, construction or demolition debris, asphalt, trash, or other deleterious materials.

We recommend that all new fill soils in paved or yard areas consist of on-site, clean, low-plasticity, cohesive soils relatively free of topsoil, vegetation, trash, construction or demolition debris, organic soils, frozen materials, particles more than 2 inches maximum diameter or other deleterious materials. The plasticity index of the fill soils should be 24 percent or less. The fill soils may be silty clays from on-site cuts that meet these criteria, or the moderately to highly weathered shales from the cuts, provided that they are pulverized to a soil-like consistency, meet the previously mentioned plasticity requirements, and are moisture-conditioned the same as a soil fill. New fills should be placed on the prepared surfaces in shallow horizontal layers, 6 to 8 inches in loose thickness. The fill should be compacted to at least 95 percent of the maximum dry density determined by the standard Proctor moisture-density test, ASTM D698. The moisture content of the fill at the time of compaction should be maintained within 2

percent below to 3 percent above the optimum moisture content. Soils within 12 inches of pavement subgrade elevation should be moisture conditioned to within two percent of the optimum moisture content and compacted to densities not less than 100 percent of the standard Proctor maximum dry density, ASTM D698, immediately prior to placing the pavement.

Fill on sloping terrain should be placed and compacted on successive horizontal benches that begin at the toe of the fill slope. The horizontal benches should be cut at least 2 feet deep below the existing ground surface, and deeper as necessary to satisfy the undercut and proofroll recommendations provided above.

We recommend that edge drains be incorporated into the pavement design as shown on the Edge Drain Detail, Drawing 080978E-7, included the Appendix to this report.

All areas disturbed during the proposed construction should be seeded, mulched or paved as soon as practical after construction so as to minimize surface erosion. During construction, straw bales or silt fences should be staked across areas of concentrated runoff to minimize the washing of silt onto adjacent properties, drainage swales, or storm sewers.

Experience has found that the optimum season of the year for earthwork in the Northern Kentucky Area is during the months of June through October because of the historically more favorable weather conditions during that period. If construction is to be performed during the winter or early spring months, care should be taken so that no concrete, asphalt, or new fills are placed over frozen or saturated soils. Additionally, frozen or saturated soils should not be used for compacted fill or backfill.

8.3 Hillside between Filter Building and Clearwell

As noted in Section 2.0 of this report, the preliminary designs available prior to the field exploration indicated that a proposed retaining wall, roughly 130 feet in length, was to be constructed on the hillside between the existing Filter Building and the round covered Clearwell structure. This structure was eliminated with subsequent design revisions and

we understand that the existing slope geometry will not change. It is our understanding that a 36-inch diameter ductile iron GAC Influent Pipe will be constructed along this slope about 30 feet from and parallel to the existing Filter Building. The existing slope geometry is approximately 2.5H:1V. We did not observe any scarps, soil creep, ground cracking, or other signs of instability during the site reconnaissance.

The proposed pipeline can be installed through this sloping area in a stable manner, provided that measures are taken to support the slope and trench while the pipe is installed, and provided that the trench backfill is placed as a structural fill so that the ground is restored to a condition equal to, or better than currently exists. We recommend that the pipeline backfill consist of controlled low-strength concrete (flowable fill) exhibiting a 28-day compressive strength between 30 and 100 pounds per square inch (psi). Further, we recommend that the flowable fill be limited to 6-inches above the pipe, and completion of the backfill up to the ground surface should use well compacted lean clay soils.

We recommend that the Contractor be responsible for providing trench support along the length of the hillside during utility construction to maintain the stability of the slope. Structure and utility backfilling recommendations are provided in Section 8.6 of this report.

8.4 Valve Vaults/Splitter Box/ EQ Discharge Headwall Structure

In our opinion, the valve vaults and the splitter box can be supported on reinforced concrete mat foundations bearing on the medium stiff to stiff existing fill soils, stiff native clays, or bedrock. If soft fill soils or soft native soils are encountered at mat foundation bearing level, these soft soils should be removed to expose medium stiff to stiff fill soils, stiff native soils or bedrock, and replaced with lean concrete exhibiting a 28-day compressive strength of at least 1500 psi. The mat foundations can be designed for a maximum allowable bearing capacity of 2000 pounds per square foot (psf). The weights of the valve vaults and splitter box are expected to be less than the weight of soil that is excavated to construct them, so settlements of the valve vaults and splitter box are expected to be very small.

It is our understanding that the foundations for the EQ Discharge Headwall Structure will bear at approximate elevation 795.0 feet. We recommend that the foundation for this headwall bear on the bedrock. It should be noted that the ground surface slopes down from the roadway toward the reservoir bottom. We anticipate that the foundation excavation will encounter bedrock closer to the reservoir road; however, fill materials may be encountered in the foundation excavation farthest from the road. These fill materials should be undercut to the top of the underlying shale and limestone bedrock and replaced with 1500 psi lean concrete as noted above.

We recommend that all bearing surfaces be covered with a thin concrete "mud mat" to protect the soils and bedrock from excessive wetting or drying and disturbance related to construction of reinforcing steel. The "mud mat" concrete should have a 28-day compressive strength of at least 1500 psi. Prior to placing any concrete "mud mat", reinforcing steel or foundation concrete, the bearing surfaces should be cleaned of all loose, wet or otherwise disturbed material to expose firm, intact, medium stiff to stiff soil or bedrock. Intact limestone encountered at subgrade elevations may remain in place provided that it can be determined that the limestone has not been disturbed and that the surrounding shales have not softened due to prior groundwater seepage. Disturbed pieces of limestone and water softened soils and shales should be removed from the bearing surfaces before the "mud mat" is placed. We recommend that the bearing surfaces be reviewed by the Project Geotechnical Engineer or his representative before the "mud mat" is placed to determine that the bearing materials and bearing surfaces are consistent with the recommendations in this report and the intent of the design.

In our opinion, the excavations through the clayey soils and into the bedrock (as needed) can be made with traditional track mounted excavating equipment. The Contractor should select a method of excavation that will protect nearby structures and infrastructure from vibration damage or other damage that may be caused during excavation.

We recommend that the Contractor be responsible for the stability and safety of all excavations, and should exercise all necessary caution to shore, slope, brace or

otherwise maintain stable and safe excavations to protect workers in the excavations as well as people and property adjacent to, above, and upslope of excavations. All Federal, State and Local safety regulations should be satisfied.

As noted above, all areas disturbed during the proposed construction should be seeded, mulched or paved as soon as practical after construction so as to minimize surface erosion. During construction, straw bales or silt fences should be staked across areas of concentrated runoff to minimize the washing of silt onto adjacent properties, drainage swales, or storm sewers.

8.5 North and South Reservoir Perimeter Roads

As noted in Section 2.0 of this report, the construction of the proposed GAC Building and associated structure and pipeline construction will result in increased traffic on the main access road from Alexandria Pike. The Design Team has proposed allowing passenger cars and light pickup trucks as well as fork trucks and/or front-end loaders use of this road as an alternative access to the plant and to potential lay down areas during construction of the plant facilities. The existing asphalt pavement perimeter roads around the north and south reservoirs currently handle very limited traffic, on the order of one car or pickup truck per day. Gated access points exist at the end of the loop roads for both the north and south reservoirs. The existing roads roughly total 4,700 feet in length, excluding the areas across the earthen reservoir dams, and vary in width from about 11 to 12 feet. The current conditions of the pavement and subgrade have been evaluated to determine the potential damage caused by the increase in traffic. The North and South Reservoir Perimeter Roads are shown on the Boring Plan, Drawing 080978E-5 included in the Appendix to this report.

It is our understanding that daily traffic consisting of about 80 passenger car and pickup truck vehicle trips as well as an occasional fork truck or front-end loader may utilize the roadway each day, seven days per week during the construction period. We further understand that the construction period will be approximately two years. To determine the ability of the existing pavement to handle the increase in traffic, we must first

determine the accumulated number of 18-kip single axle load applications, defined as Equivalent Axle Loads (EAL's) for the roadways in question.

For modeling purposes, we estimated front and rear 2-kip single axle loads for passenger cars. For unloaded (non construction) pickup trucks, we estimated 2-kip single axle loads for the front and 4-kip single axle loads for the rear. For loaded pneumatic rubber tired fork truck or front-end loaders we estimated 18-kip single axle loads for the front and 12-kip single axle loads for the rear.

Pavement design analyses in this report used the Pavement Analysis Software program (version 3.0, 1988) developed by Mr. Thomas P. Hartman and based on the American Association of State Highway and Transportation Officials (AASHTO) "Guide for the Design of Pavement Structures" manual (1986). Based on the results of the field exploration, we have estimated a California Bearing Ratio (CBR) value of 3 for the stiff silty clay subgrade materials. The subgrade resilient modulus (M_r) of this material is related to the CBR and is estimated to be approximately 4500 psi.

The selected design thickness (T_p) of the existing pavement is approximately 3.5 inches, and the existing pavement has some longitudinal, alligator and stress cracking. An Asphalt Institute conversion factor (C_f) of 0.8, based on the type and condition of the existing pavement, was used to determine the effective design thickness (ET_p) of the existing pavement as shown below:

$$ET_p = T_p \times C_f$$

Where:
Effective Thickness of Existing Pavement = ET_p = 2.8 inches
Thickness of Existing Pavement = T_p = 3.5 inches
Conversion Factor = C_f = 0.8

The pavement Structural Number (SN) was determined using the effective pavement thickness as well as the layer and drainage coefficients as follows:

$$SN = a_i \times C_d \times ET_p$$

Where:

SN = Structural Number = 1.12

a_i = Layer Coefficient = 0.4

C_d = Drainage Coefficient = 1.0

Additional parameters used in the pavement evaluation are the initial and terminal serviceability (P_i and P_t, respectively), which are based on a numerical rating of the existing pavement condition and the condition of the pavement at the end of its design life prior to resurfacing. Other parameters used are the Reliability (R) and Overall Deviation (D). Values for these parameters used are shown below:

P_i = Initial Serviceability = 3.5

P_t = Terminal Serviceability = 2.0

R = Reliability = 65 (low priority, local, urban street)

D = Overall Deviation = 0.45 (flexible pavement)

The use of these design parameters yields a capacity of 1,200 EAL's. Based on the traffic mix and wheel loads noted above, the existing pavement can service 60 passenger car trips and 20 pickup truck trips per day for 20 years with reasonable and normal maintenance, but the addition of as little as two (2) fork truck trips per day during the 2 year construction period would take the existing pavement to its terminal serviceability, and would necessitate overlays or repairs for the pavement to provide service for the normal passenger cars and light trucks during the years following the GAC Building construction. In our opinion, there are two options available to the Design Team for the reservoir perimeter roads:

Option 1

Use the perimeter roads to handle overflow passenger car and light pickup truck (but no construction vehicle) traffic for the 2-year construction period, and then have the

pavement remain structurally serviceable for normal passenger car and light pickup truck traffic to the end of a 20-year design life with normal and reasonable maintenance.

Option 2

Using the perimeter roads to handle overflow passenger car and pickup truck traffic plus front-end loader/fork-truck traffic during the construction period will require an asphalt overlay of between 1 and 2 inches, depending on the type and frequency of traffic anticipated. For example: If a 1-inch asphalt pavement overlay is added to the existing pavement, it would increase the design capacity to roughly 6,000 EAL's, allowing up to 6 front-end loader/fork truck trips per day during the two (2) year construction period. These trips would be in addition to the 80-passenger car and pickup truck trips daily. If a 2-inch asphalt overlay were added, it would allow for up to 20 front-end loader/fork truck trips per day during the two (2) year construction period.

It should be noted that the existing pavement was only 2 inches thick in one (1) of the thirteen (13) borings (TB #1009) made around the reservoirs. This one "thin" pavement section did not warrant assuming that the existing pavement was only 2 inches thick in the analysis of the pavement, but it does indicate that there are isolated "thin" pavement sections that may fail under the discussed traffic, and will require localized repairs.

It also should be noted that this pavement analysis did not include the pavement across the dams. This analysis assumes that traffic across the dams will be prohibited. The dams and their pavements are being evaluated in a separate study, and will be reported under separate cover.

8.6 Structure and Utility Backfill Materials

All foundation excavations within the areas described in this report should be backfilled with compacted and tested lean clay fill with a plasticity index of 24 or less, or with lean concrete backfill with a minimum 28-day compressive strength of 1,500 psi. Clay backfill layers should be placed in shallow level layers, 6 to 8 inches in thickness, and compacted to a density not less than 95 percent of the standard Proctor maximum dry density (ASTM D698). All clayey soil materials used as backfill should be moisture

conditioned to within a range of 2 percent below to 3 percent above the optimum moisture content for compaction. The type and weight of compaction equipment should be carefully selected so as to achieve the compaction while not overstressing structure walls. If a drainage system will be used, we recommend that free-draining granular backfill with a compacted clay surface cap be used above the drain level and lean concrete backfill be used below drain level.

Normal and recommended utility construction practice is to bed and backfill pipes with granular fill to at least 6-inches above the crown of the pipe, and then complete the backfilling up to ground surface with well-compacted clay soils. Compaction of trench backfill to a moist, firm, dense condition is important for all pipelines. We recommend that all pipeline backfill for this project be placed in shallow level layers, 6 to 8 inches in thickness, and compacted to densities not less than 95 percent of the standard Proctor maximum dry density (ASTM D698). We recommend that pipe trench granular backfill be limited to pipe bedding and to 6-inches above the pipe, except where those pipes are within free-draining granular backfill for a structure. All granular backfill should be compacted to at least 75 percent relative density, per ASTM D4253 and D4254. Under no circumstances should any backfill be flushed to obtain compaction.

The excavations for all utility/pipe trenches must be made in a manner that provides for the safety of workers in the excavations and protects existing ground, structures, and infrastructure adjacent to the excavations from damage. The excavations should be braced, shored, sloped, or otherwise stabilized in a manner that satisfies all safety concerns and all federal, state, and local regulations. The responsibility of maintaining safe working conditions in the excavations and for protecting ground, structures, and infrastructure adjacent to the excavations should be the Contractors. Additionally, the Contractor should be responsible for maintaining the stability of all existing utilities during the installation of utility/pipelines.

8.7 Lateral Earth Pressures and Buoyancy

The below-grade structure walls should be designed to accommodate at-rest lateral earth pressures plus all applicable ground surface surcharges. The magnitude of the

lateral earth and water pressures will depend on the type of backfill material, and whether or not a drainage system with a permanent drainage outlet is provided around the below-grade portions of the structures.

The lowest design lateral earth pressures will result if a drainage system is provided around the structures. If a drainage system is utilized, the system should consist of a minimum 12-inch wide zone of free-draining granular backfill with less than three (3) percent particle sizes passing the No. 200 sieve. The free-draining granular backfill should be separated from the compacted clay cap and from the shale and limestone bedrock with a non-woven geotextile filter fabric, such as Mirafi 140N, specifically designed for filtration. The drainage system should have a perforated drainpipe with a permanent outlet.

The recommended design lateral earth pressures depend on whether or not a drainage system is provided. If a drainage system is provided, we recommend using a drained Equivalent Fluid Weight (EFW) of 57 pounds per cubic foot (pcf) from the ground surface down to the bottom of the drainage system. All foundation walls below the level of the drain system should be backfilled with lean concrete as noted in Section 8.6 above. Granular backfill should not be used as backfill in these areas. We recommend using an undrained EFW of 62.4 pcf for backfill to the bottom of the foundations. However, the height of the lifts of lean concrete backfill should be limited so that the capacity of the wall is not exceeded while the lean concrete fill is fluid. We recommend that the below-grade walls with no drainage system be designed using an undrained EFW of 100 pcf from the ground surface down to the bottom of the foundation. It should be noted that these EFW values provided are for the "at-rest" condition, and assume the tops of the structure walls are restrained and are not free to deflect. Additionally, please note that the undrained EFW values include fluid pressure.

The structure should be designed to resist buoyant uplift forces, assuming that water can build up around the structure to the level of the drain system. The resistance to uplift should be provided by a combination of the dead weight of the structure, dead weight of any soil/concrete backfill atop foundation projections beyond the structure

walls, frictional resistance around the perimeter of the structure and/or tie-down anchors.

The frictional resistance around the perimeter can be estimated with an ultimate friction factor of 0.3 for select granular backfill above any drain level and an ultimate adhesion factor of 500 psf for clayey soil backfill if a drain is not used. An adequate factor of safety should be applied to this ultimate friction factor/adhesion value.

Tie-down anchors with bond zones in the unweathered bedrock beneath the structure could be designed for an allowable anchor bond stress of 25 pounds per square inch (psi) between the anchor grout and the bedrock, provided the design anchor capacities are confirmed by performance and proof-load testing during construction. The performance and proof-load testing should be in accordance with Post-Tensioning Institute criteria or other approved industry standards. The performance and proof-load testing procedures should be clearly outlined in the project specifications.

8.8 Pavements

Pavements for this project should be designed in accordance with expected axle loads, frequency of loading and the properties of the subgrade. The subgrade properties should be evaluated by field CBR or plate load tests after final grading is completed or by the correlation of field density tests to laboratory CBR tests. In each case, we recommend that the upper 12 inches of subgrade be compacted within 2 percent of optimum moisture content to at least 100 percent of maximum density as determined by the standard Proctor moisture-density test, ASTM D698.

We recommend that if a dumpster will be used at the project site, the dumpster should be supported on a concrete slab and the slab should be sized to accommodate the loading wheels of the dumpster truck. In addition, pavements servicing dumpsters should be designed for the heavier loads associated with the dumpster trucks.

Surface drainage should be directed away from the edges of proposed or existing pavements so that water does not pond next to pavements or flow onto pavements from

unpaved areas. Such ponding or flow can cause deterioration of pavement subgrades and premature failure of pavements. If drainage ditches are used to intercept surface water before it reaches the pavements, the ditches should have an invert at least 6 inches below the pavement subgrade, and have a longitudinal gradient that causes the ditches to drain rapidly and not pond water. If these criteria cannot be met, consideration should be given to incorporating edge drains into the pavement design.

The off-site disposal of the excavated material for this project will result in a larger-than-normal amount of construction truck traffic on the existing FTTP access road. This should be taken into consideration in the assessment of potential damage to the existing road during construction of the GAC Building.

9.0 CLOSURE

The conclusions and recommendations of this report have been derived by relating the general principles of the discipline of Geotechnical Engineering to the proposed construction outlined by the Project Characteristics section of this report. Because changes in surface, subsurface, climatic, and economic conditions can occur with time and location, we recommend for our mutual interest that the use of this report be restricted to this specific project.

Our understanding of the proposed design and construction is based on the documents and information provided to us at the time this report was prepared and which are referenced in the Project Description section of this report. We recommend that our office be retained to review the final design documents, plans, and specifications to assess any impact changes, additions or revisions in these documents may have on the conclusions and recommendations of this Geotechnical Report. Any changes or modifications that are made in the field during the construction phase, which alter site grading, structure locations, infrastructure or other related site work should also be reviewed by our office prior to their implementation.

Recommendations have been provided in the various sections of this report. The report shall, therefore, be used in its entirety. The Designer should see that all parties have

the entire report with all possible supplementary information for their respective use and that they understand the intent of the contents. This report is not a bidding document and shall not be used for that purpose. Anyone reviewing this report must interpret and draw conclusions regarding specific construction techniques and methods each chooses to use.

APPENDIX

ASFE Report Information

Tabulation of Laboratory Tests

Unconfined Compressive Strength Test Form - Soil

Test Boring Logs, 080978E

Test Boring Logs, 87343E, 89079E, 980640E, and 990146E

Soil Classification Sheet

Rock Weathering and Strength Classification Sheet

Edge Drain Detail, Drawing 080978E-7

Boring Plan, Drawing 080978E-5 (In Pocket)

Boring Plan Detail, Drawing 080978E-6 (In Pocket)

Important Information about Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

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IIGER06085.0MRP

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TABULATION OF LABORATORY TESTS

Boring Number	Sample Number	Depth, ft. From	Depth, ft. To	Moisture Content, %	Atterberg Limits, % LL	Atterberg Limits, % PL	Atterberg Limits, % PI	Natural Dry Density, pcf	Unconfined Compressive Strength, psf	USCS Classification
1001	2	2.6	4.1	14.7						
	4	7.5	9.0	9.9						
1002	1B	0.3	1.5	18.6						
	3	5.0	6.5	11.8						
	5	10.0	11.0	11.8						
1003	2	2.5	4.0	18.4						
	4	7.5	9.0	21.0						
	6	12.5	14.0	17.2						
	8	17.5	19.0	16.0						
	10	25.0	26.5	10.5						
	12	35.0	36.5	19.9						
	14	45.0	46.5	31.4						
1004	1B	0.3	1.5	17.1						
	2	3.0	5.0	18.1	45	26	19	113.0	6,220	CL
	3	5.0	6.5	17.1						
	5	10.0	11.5	20.3						
	7	15.0	16.5	24.6						
	9	20.0	21.5	13.9						
	12	35.0	36.5	22.7						
	14	45.0	45.5	8.7						
1005	2	2.5	4.0	20.6						
	4	7.5	9.0	16.9						
	6	12.5	14.0	23.7						
	8	17.5	19.0	16.6						
	10	22.5	24.0	14.3						

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TABULATION OF LABORATORY TESTS

Boring Number	Sample Number	Depth, ft. From	Depth, ft. To	Moisture Content, %	Atterberg Limits, % LL	Atterberg Limits, % PL	Atterberg Limits, % PI	Natural Dry Density, pcf	Unconfined Compressive Strength, psf	USCS Classification
1006	1	0.3	1.8	5.9						
	2	1.8	3.3	17.6						
1007	1A	0.7	1.3	7.0						
	1B	1.3	1.9	16.9						
	2	2.2	3.7	18.7						
1008	1	0.3	1.8	18.9						
	2	1.8	2.8	19.2						
1009	1	0.2	1.7	7.7						
	2	1.7	3.2	14.7						
1010	1	0.3	1.8	21.5						
	2	1.8	3.3	19.5						
1011	1	0.5	2.0	9.1						
	2	2.0	3.5	12.9						
1012	1	0.3	1.8	12.2						
	2	1.8	3.3	27.5						
1013	1	0.4	1.4	11.8						
	2	1.4	2.9	3.3						
1014	1	0.3	1.8	24.4						
	2	1.8	3.3	11.7						

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TABULATION OF LABORATORY TESTS

Boring Number	Sample Number	Depth, ft. From	Depth, ft. To	Moisture Content, %	Atterberg Limits, % LL	Atterberg Limits, % PL	Atterberg Limits, % PI	Natural Dry Density, pcf	Unconfined Compressive Strength, psf	USCS Classification
1015	1	0.5	2.0	9.0						
	2	2.0	3.5	25.1						
1016	1	0.3	1.8	10.9						
	2	1.8	3.3	28.1						
1017	1	0.5	2.0	25.1						
	2	2.0	3.5	20.6						
1018	1	0.3	1.8	16.4						
	2	1.8	2.0	7.8						

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UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL, ASTM - D2166
UNIT WEIGHT AND NATURAL MOISTURE

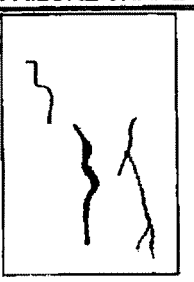
CLIENT : CH2M Hill
PROJECT: Geotechnical Exploration, Advanced Treatment GAC, FTTP Addendum 1
LOCATION: Fort thomas, Kentucky

PROJECT NUMBER: 080978E
BORING NO.: 1004 SAMPLE NUMBER: PT-2 DEPTH (ft.): 3.5-3.6
SAMPLE DESCRIPTION: Mixed brown trace gray moist stiff to very stiff FILL, silty clay, soime shale and limestone floaters

SAMPLE OBTAINED BY: Shelby Tube CONDITION: Undisturbed DATE: 9/11/2009

NATURAL UNIT WEIGHT	
AVERAGE DIAMETER (in.)	2.83
HEIGHT (in.)	5.23
HEIGHT TO DIAMETER RATIO	1.85
AVERAGE AREA (sq. ft.)	0.0437
VOLUME (cu. ft.)	0.0191
WET WEIGHT (lbs.)	2.54
DRY WEIGHT (lbs.)	2.15
DRY DENSITY (pcf)	**113.0**

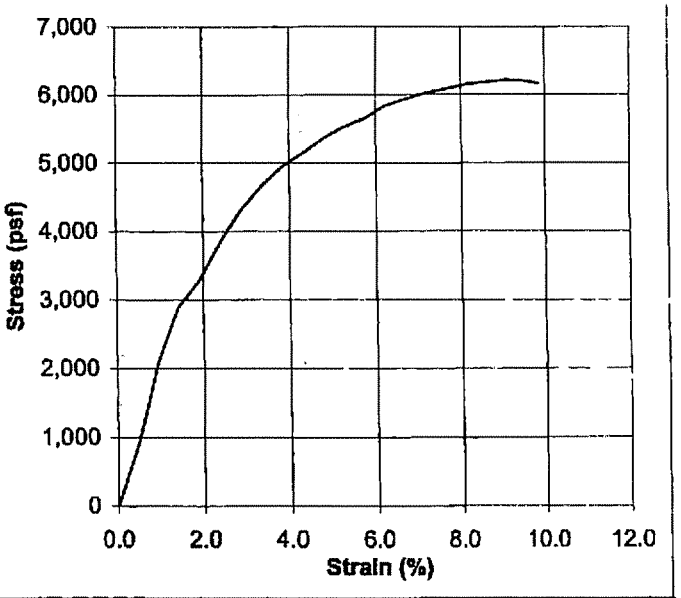
FAILURE SHAPE



WATER CONTENT AFTER SHEAR	
CAN NUMBER	A-12
WET WEIGHT + CAN (lbs.)	3.45
DRY WEIGHT + CAN (lbs.)	3.06
WEIGHT WATER (lbs.)	0.39
WEIGHT CAN (lbs.)	0.91
WEIGHT SOLID (lbs.)	2.15
MOISTURE (%)	**18.1**

PROVING RING NO.: 22714

DEFORM DIAL (0.001 in.)	LOAD DIAL (0.001 In.)	LOAD (lbs.)	STRAIN (%)	CORR. AREA ($ft.^2$)	STRESS (psf)
0	0	0.0	0.0	0.0437	0
25	125	39.7	0.5	0.0440	903
50	295	92.5	1.0	0.0442	2,095
75	410	128.2	1.4	0.0444	2,890
100	455	146.1	1.9	0.0446	3,276
125	488	171.5	2.4	0.0448	3,826
150	517	193.8	2.9	0.0450	4,302
175	539	210.7	3.3	0.0453	4,655
200	557	224.5	3.8	0.0455	4,936
250	585	246.0	4.8	0.0459	5,355
275	597	255.2	5.3	0.0462	5,528
300	606	262.2	5.7	0.0464	5,649
325	619	272.1	6.2	0.0466	5,835
350	627	278.3	6.7	0.0469	5,936
375	634	283.7	7.2	0.0471	6,020
400	640	288.3	7.6	0.0474	6,086
425	646	292.9	8.1	0.0476	6,152
450	650	296.0	8.6	0.0479	6,184
475	654	299.0	9.1	0.0481	6,215
500	655	299.8	9.6	0.0484	6,199
515	654	299.0	9.8	0.0485	6,163



AVERAGE RATE OF STRAIN TO FAILURE (%/min.)	**1.0**
STRAIN AT FAILURE (%)	**9.1**
UNCONFINED COMPRESSIVE STRENGTH (psf)	**6,220**
SHEAR STRENGTH (psf)	**3,110**

REMARKS :

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING # 1001

PROJECT: Geotechnical Exploration, Advanced Treatment Improv.-Additional Improv., Ft. Thomas, Kentucky JOB # 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-5

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. inches
753.2	SURFACE	0.5						
752.7	ASPHALT (6 inches)	1.1		I	2/4/3	1	DS	9
752.1	CONCRETE (7 inches)	2.6		I	7/12/19	2	DS	16
750.6	Mixed brown moist loose FILL, fine to coarse clayey sand, trace gravel.		5	I	19/23/50	3	DS	18
746.2	Interbedded brown to olive brown and gray moist soft weathered SHALE and gray hard LIMESTONE (bedrock).	7.0						
744.2	Interbedded gray, trace brown moist soft moderately weathred SHALE and gray hard LIMESTONE (bedrock).	9.0		I	15/39/81	4	DS	15
	Bottom of test boring at 9.0 feet.		10					
	Notes: 1. Augered through concrete 2. Surface water from rain event entered boring prior to final water reading.		15					
			20					
			25					

Datum	MSL	Hammer Wt.	140 lbs.	Hole Diameter	8 in.	Foreman	JS / TD-2
Surf. Elev.	753.2 ft.	Hammer Drop	30 in.	Rock Core Dia.	-- in.	Engineer	LJC
Date Started	8/19/09	Pipe Size	O.D. 2 in.	Boring Method	3-1/4" HSA	Date Completed	8/19/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUND WATER DEPTH
FIRST NOTED 5.9 ft.
AT COMPLETION Dry ft.
AFTER 23 hrs. 4.8 ft.
BACKFILLED 23 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING # 1002

PROJECT: Geotechnical Exploration, Advanced Treatment Improv.-Additional Improv., Ft. Thomas, Kentucky JOB # 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-5

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. inches
763.7	SURFACE	0.3						
763.4	TOPSOIL (4 inches)	2.0		I	3/4/4	1A 1B	DS	15
761.7	Mixed brown moist stiff FILL, silty clay, some limestone and shale fragments.			I	50/3"	2	DS	3
	Interbedded brown moist soft moderately weathered SHALE and gray hard LIMESTONE (bedrock).		5	I	36/50/6"	3	DS	1
				I	33/50/6"	4	DS	10
752.7		11.0	10	I	26/72/6"	5	DS	12
	Bottom of test boring at 11.0 feet.		15					
			20					
			25					

Datum	MSL	Hammer Wt.	140 lbs.	Hole Diameter	8 in.	Foreman	JS / TD-2
Surf. Elev.	763.7 ft.	Hammer Drop	30 in.	Rock Core Dia.	-- in.	Engineer	LJC
Date Started	8/19/09	Pipe Size	O.D. 2 in.	Boring Method	3-1/4" HSA	Date Completed	8/19/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER 22 hrs. Dry ft.
BACKFILLED 22 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING # 1003 (1 of 2)

PROJECT: Geotechnical Exploration, Advanced Treatment Improv.-Additional Improv., Ft. Thomas, Kentucky JOB # 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-5

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. inches
776.6	SURFACE	0.0						
	Mixed brown moist medium stiff FILL, clay, some topsoil, trace fine to coarse sand and gravel and hairlike roots.	2.0		I	1/1/2	1	DS	8
774.6	Gasoline smell noted.			I	5/3/6	2	DS	10
	Mixed brown moist medium stiff FILL, silty clay, with limestone gravel, trace shale fragments.	4.5	5	I	4/4/4	3	DS	17
772.1								
	Mixed brown, trace gray moist stiff FILL, silty clay, trace shale and limestone fragments and topsoil.	7.0		I	5/4/4	4	DS	10
769.6			10	I	6/3/17	5	DS	9
	Mixed brown moist stiff FILL, silty clay, some fine to coarse sand, shale and limestone fragments.			I	24/9/5	6	DS	9
			15	I	4/2/2	7	DS	16
				I	7/12/6	8	DS	7
			20	I	2/4/3	9	DS	4
			25	I	11/26/23	10	DS	7
748.6		28.0						
	Mixed brown, trace green and gray moist stiff FILL, clay, trace topsoil and gravel.							

Datum	MSL	Hammer Wt.	140 lbs.	Hole Diameter	8 in.	Foreman	JS / TD-2
Surf. Elev.	776.6 ft.	Hammer Drop	30 in.	Rock Core Dia.	-- in.	Engineer	LJC
Date Started	8/18/09	Pipe Size	O.D. 2 in.	Boring Method	3-1/4" HSA	Date Completed	8/18/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER 17 hrs. Dry ft.
BACKFILLED 17 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING # 1003 (2 of 2)

PROJECT: Geotechnical Exploration, Advanced Treatment Improv.-Additional Improv., Ft. Thomas, Kentucky JOB # 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-5

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. inches
733.6	Mixed brown, trace green and gray moist stiff FILL, clay, trace topsoil and gravel.	43.0	30	I	3/5/6	11	DS	18
728.1	Gray and blue-green moist medium stiff CLAY.	48.5	35	I	3/6/7	12	DS	18
			40	I	4/5/8	13	DS	18
			45	I	2/2/3	14	DS	18
725.6	Interbedded gray moist soft slightly weathered SHALE and gray hard LIMESTONE (bedrock).	51.0	50	I	29/54/6"	15	DS	12
	Bottom of test boring at 51.0 feet.		55					

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 8 in. Foreman JS / TD-2

Surf. Elev. 776.6 ft. Hammer Drop 30 in. Rock Core Dia. – in. Engineer LJC

Date Started 8/18/09 Pipe Size O.D. 2 in. Boring Method 3-1/4" HSA Date Completed 8/18/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER 17 hrs. Dry ft.
BACKFILLED 17 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING # 1004 (1 of 2)

PROJECT: Geotechnical Exploration, Advanced Treatment Improv.-Additional Improv., Ft. Thomas, Kentucky JOB # 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-5

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. inches
768.6	SURFACE	0.3						
768.3	TOPSOIL (4 inches)			I	2/2/2	1A 1B	DS	18
765.2	Mixed brown moist very stiff FILL, silty clay, trace topsoil, gravel and hairlike roots.	3.4		U		2	PT	16/24
			5	I	9/7/9	3	DS	18
				I	4/5/7	4	DS	18
	Mixed brown, trace gray moist stiff to very stiff FILL, silty clay, some shale and limestone.		10	I	5/6/7	5	DS	4
				I	11/6/6	6	DS	17
			15	I	2/4/5	7	DS	16
751.6		17.0						
				I	29/7/7	8	DS	6
			20	I	4/4/8	9	DS	1
	Mixed brown, some gray moist stiff FILL, silty clay, trace shale and limestone floaters.							
			25	I	3/3/3	10	DS	18
740.6		28.0						
	Mixed brown and gray wet loose FILL, coarse sand and gravel, trace silty clay (pea gravel).							

Datum	MSL	Hammer Wt.	140 lbs.	Hole Diameter	8 in.	Foreman	JS / TD-2
Surf. Elev.	768.6 ft.	Hammer Drop	30 in.	Rock Core Dia.	-- in.	Engineer	LJC
Date Started	8/18/09	Pipe Size	O.D. 2 in.	Boring Method	3-1/4" HSA	Date Completed	8/18/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUND WATER DEPTH
FIRST NOTED 30 ft.
AT COMPLETION 31.4 ft.
AFTER 29 hrs. 29.5 ft.
BACKFILLED 29 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING # 1004 (2 of 2)

PROJECT: Geotechnical Exploration, Advanced Treatment Improv.-Additional Improv., Ft. Thomas, Kentucky JOB # 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-5

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. inches
735.6	Mixed brown and gray wet loose FILL, coarse sand and gravel, trace silty clay (pea gravel).	33.0	30	D	2/2/2	11	DS	7
728.6	Mixed brown very moist soft FILL, silty clay, with fine to coarse sand, trace gravel.	40.0	35	I	3/2/3	12	DS	18
723.1	Interbedded gray moist soft slightly weathered SHALE and gray hard LIMESTONE (bedrock).	45.5	40	I	50/1"	13	DS	1
	Bottom of test boring at 45.5 feet.		45		50/6"	14	DS	3
			50					
			55					

Datum	MSL	Hammer Wt.	140 lbs.	Hole Diameter	8 in.	Foreman	JS / TD-2
Surf. Elev.	768.6 ft.	Hammer Drop	30 in.	Rock Core Dia.	-- in.	Engineer	LJC
Date Started	8/18/09	Pipe Size	O.D. 2 in.	Boring Method	3-1/4" HSA	Date Completed	8/18/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUND WATER DEPTH
FIRST NOTED 30 ft.
AT COMPLETION 31.4 ft.
AFTER 29 hrs. 29.5 ft.
BACKFILLED 29 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING # 1005

PROJECT: Geotechnical Exploration, Advanced Treatment Improv.-Additional Improv., Ft. Thomas, Kentucky JOB # 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-5

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. inches
773.4	SURFACE	0.5						
772.9	TOPSOIL (6 inches)			I	2/3/3	1A 1B	DS	18
768.9	Mixed brown and gray moist very stiff FILL, silty clay, with limestone fragments, trace fine to coarse sand.	4.5		I	3/4/7	2	DS	18
766.4	Mixed brown and gray moist loose FILL, coarse sand and gravel (pea gravel).	7.0	5	I	1/2/2	3	DS	4
763.9	Mixed brown moist stiff to very stiff FILL, silty clay, with shale and limestone fragments, some pea gravel.	9.5		I	4/50/3"	4	DS	4
761.4	Mixed brown and gray moist medium stiff FILL, silty clay, trace gravel.	12.0	10	I	3/3/3	5	DS	18
756.4	Mixed brown and blue-gray moist stiff FILL, silty clay, with shale fragments.	17.0	15	I	3/4/6	6	DS	18
753.9	Brown, trace gray moist stiff SILTY CLAY, with shale fragments.	19.5		I	4/5/7	7	DS	18
748.9	Interbedded brown moist soft moderately weathered SHALE and gray hard LIMESTONE (bedrock).	24.5	20	I	8/10/12	8	DS	18
747.6	Interbedded gray moist soft slightly weathered SHALE and gray hard LIMESTONE (bedrock).	25.8	25	I	12/18/21	9	DS	18
	Bottom of test boring at 25.8 feet.			I	21/50/3"	10	DS	6
				I	81/50/3"	11	DS	8

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 8 in. Foreman LW / TD-2

Surf. Elev. 773.4 ft. Hammer Drop 30 in. Rock Core Dia. -- in. Engineer LJC

Date Started 8/14/09 Pipe Size O.D. 2 in. Boring Method 3-1/4" HSA Date Completed 8/14/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER 2 hrs. Dry ft.
BACKFILLED 2 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING # 1006

PROJECT: Geotechnical Exploration, Advanced Treatment Improv.-Additional Improv., Ft. Thomas, Kentucky JOB # 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-5

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. inches
802.6	SURFACE	0.3					
802.3	ASPHALT (3 ½ inches)	1.7	I	24/37/25	1	DS	18
800.9	Mixed brown moist stiff FILL, silty clay, with limestone floaters.	3.3	I	19/17/23	2	DS	18
799.3	Interbedded brown moist soft highly weathered SHALE and gray hard LIMESTONE (bedrock).						
	Bottom of test boring at 3.3 feet.						

DEPTH SCALE feet: 5, 10, 15, 20, 25

Datum MSL | Hammer Wt. 140 lbs. | Hole Diameter 5 in. | Foreman BR / D-6

Surf. Elev. 802.6 ft. | Hammer Drop 30 in. | Rock Core Dia. – in. | Engineer LJC

Date Started 8/25/09 | Pipe Size O.D. 2 in. | Boring Method CFA | Date Completed 8/25/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER -- hrs. – ft.
BACKFILLED 1 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING # 1007

PROJECT: Geotechnical Exploration, Advanced Treatment Improv.-Additional Improv., Ft. Thomas, Kentucky JOB # 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-5

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. Inches
805.0	SURFACE	0.0						
		0.7		X				
804.3	ASPHALT (8 inches)	1.3		D/I	7/12/43	1A 1B 1C	DS	18
		1.9						
803.7	Mixed brown slightly moist loose to medium dense FILL, sand and gravel (base).			I	21/29/56	2	DS	14
		4.5						
803.1	Mixed brown moist very stiff FILL, silty clay, with shale and limestone fragments.	5.9	5	I	31/50/5"	3	DS	11
800.5	Interbedded brown moist soft weathered SHALE and gray hard LIMESTONE (bedrock).							
799.1	Interbedded brown, some gray moist soft moderately weathered SHALE and gray hard LIMESTONE (bedrock).		10					
	Bottom of test boring at 5.9 feet.		15					
			20					
			25					

Datum	MSL	Hammer Wt.	140 lbs.	Hole Diameter	5 in.	Foreman	BR / D-6
Surf. Elev.	805.0 ft.	Hammer Drop	30 in.	Rock Core Dia.	-- in.	Engineer	LJC
Date Started	8/25/09	Pipe Size	O.D. 2 in.	Boring Method	CFA	Date Completed	8/25/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUND WATER DEPTH
FIRST NOTED Dry ft.
AT COMPLETION Dry ft.
AFTER -- hrs. -- ft.
BACKFILLED 1 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING # 1008

PROJECT: Geotechnical Exploration, Advanced Treatment Improv.-Additional Improv., Ft. Thomas, Kentucky JOB # 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-5

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. Inches
805.0	SURFACE	0.3						
804.7	ASPHALT (4 inches)	1.3		I	13/14/16	1	DS	18
803.7	Mixed brown moist medium stiff FILL, silty clay, with limestone floaters.	2.8		I	11/50/6"	2	DS	12
802.2	Interbedded brown moist soft highly weathered SHALE and gray hard LIMESTONE (bedrock).		5					
	Bottom of test boring at 2.8 feet.		10					
			15					
			20					
			25					

Datum	MSL	Hammer Wt.	140 lbs.	Hole Diameter	5 in.	Foreman	BR / D-6		
Surf. Elev.	805.0 ft.	Hammer Drop	30 in.	Rock Core Dia.	-- in.	Engineer	LJC		
Date Started	8/25/09	Pipe Size	O.D. 2 in.	Boring Method	CFA	Date Completed	8/25/09		

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER -- hrs. -- ft.
BACKFILLED 1 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING # 1009

PROJECT: Geotechnical Exploration, Advanced Treatment Improv.-Additional Improv., Ft. Thomas, Kentucky JOB # 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-5

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. inches
805.0	SURFACE	0.2						
804.8	ASPHALT (2 inches)	1.6		I	11/14/14	1	DS	18
803.4	Mixed brown moist stiff FILL, silty clay, with shale and limestone fragments, trace brick fragments.	3.2		I	7/12/14	2	DS	12
801.8	Mixed brown moist very stiff FILL, silty clay, with shale and limestone fragments.							
	Bottom of test boring at 3.2 feet.							

5
10
15
20
25

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman BR / D-6

Surf. Elev. 805.0 ft. Hammer Drop 30 in. Rock Core Dia. -- in. Engineer LJC

Date Started 8/25/09 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 8/25/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER -- hrs. -- ft.
BACKFILLED 1 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING # 1010

PROJECT: Geotechnical Exploration, Advanced Treatment Improv.-Additional Improv., Ft. Thomas, Kentucky JOB # 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-5

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. inches
804.9	SURFACE	0.3						
804.6	ASPHALT (3½ inches)			I	23/14/10	1	DS	18
801.6	Brown moist stiff to very stiff SILTY CLAY, with limestone and shale fragments, trace oxide stains.	3.3		I	6/6/9	2	DS	18
	Bottom of test boring at 3.3 feet.		5 10 15 20 25					

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman BR / D-6

Surf. Elev. 804.9 ft. Hammer Drop 30 in. Rock Core Dia. -- in. Engineer LJC

Date Started 8/25/09 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 8/25/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER -- hrs. -- ft.
BACKFILLED 1 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING # 1011

PROJECT: Geotechnical Exploration, Advanced Treatment Improv.-Additional Improv., Ft. Thomas, Kentucky JOB # 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-5

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. inches
804.7	SURFACE							
		0.6						
804.2	ASPHALT (7 inches)	2.0		I	5/7/5	1	DS	6
802.7	Mixed brown moist medium stiff FILL, silty clay and crushed limestone (base).	3.5		I	5/11/24	2	DS	6
801.2	Mixed brown moist stiff FILL, silty clay, with limestone fragments.							
	Bottom of test boring at 3.5 feet.							

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman BR / D-6

Surf. Elev. 804.7 ft. Hammer Drop 30 in. Rock Core Dia. -- in. Engineer LJC

Date Started 8/25/09 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 8/25/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER -- hrs. -- ft.
BACKFILLED 1 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING # 1012

PROJECT: Geotechnical Exploration, Advanced Treatment Improv.-Additional Improv., Ft. Thomas, Kentucky JOB # 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-5

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. inches
804.7	SURFACE	0.3						
804.4	ASPHALT (3 inches)	0.8		I	50/4"	1	DS	3
803.9	Mixed brown very moist stiff FILL, silty clay, with crushed limestone (base).	3.3		I	5/6/9	2	DS	18
801.4	Brown moist very stiff SILTY CLAY, with oxide stains.							
	Bottom of test boring at 3.3 feet.							

5 10 15 20 25

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman BR / D-6

Surf. Elev. 804.7 ft. Hammer Drop 30 in. Rock Core Dia. -- in. Engineer LJC

Date Started 8/25/09 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 8/25/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER -- hrs. -- ft.
BACKFILLED 1 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING # 1013

PROJECT: Geotechnical Exploration, Advanced Treatment Improv.-Additional Improv., Ft. Thomas, Kentucky JOB # 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-5

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. Inches
804.8	SURFACE	0.4						
804.4	ASPHALT (5 inches)			I	26/50/6"	1	DS	6
801.9	Mixed brown very moist stiff FILL, silty clay, with crushed limestone (base).	2.9		I	16/15/16	2	DS	2
	Bottom of test boring at 2.9 feet.		5 10 15 20 25					

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman BR / D-6

Surf. Elev. 804.8 ft. Hammer Drop 30 in. Rock Core Dia. -- in. Engineer LJC

Date Started 8/25/09 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 8/25/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER -- hrs. -- ft.
BACKFILLED 1 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING # 1014

PROJECT: Geotechnical Exploration, Advanced Treatment Improv.-Additional Improv., Ft. Thomas, Kentucky JOB # 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-5

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. inches
804.7	SURFACE	0.3						
804.4	ASPHALT (4 inches)			I	8/8/8	1	DS	18
801.4	Mixed brown moist stiff FILL, silty clay, with crushed limestone (base).	3.3		I	4/4/7	2	DS	3
	Bottom of test boring at 3.3 feet.		5 10 15 20 25					

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman BR / D-6

Surf. Elev. 804.7 ft. Hammer Drop 30 in. Rock Core Dia. -- in. Engineer LJC

Date Started 8/25/09 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 8/25/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER -- hrs. -- ft.
BACKFILLED 1 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING # 1015

PROJECT: Geotechnical Exploration, Advanced Treatment Improv.-Additional Improv., Ft. Thomas, Kentucky JOB # 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-5

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. inches
805.0	SURFACE	0.5						
804.5	ASPHALT (5 ½ inches)	1.8		I	15/12/8	1	DS	6
803.2	Mixed brown moist stiff FILL, silty clay, with crushed limestone (base).	3.5		I	3/5/6	2	DS	18
801.5	Brown moist stiff SILTY CLAY, with oxide stains.		5					
	Bottom of test boring at 3.5 feet.		10					
			15					
			20					
			25					

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman BR / D-6

Surf. Elev. 805.0 ft. Hammer Drop 30 in. Rock Core Dia. -- in. Engineer LJC

Date Started 8/25/09 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 8/25/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER -- hrs. -- ft.
BACKFILLED 1 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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www.thelenassoc.com
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Cincinnati, Ohio
Dayton, Ohio

LOG OF TEST BORING

CLIENT: CH2M Hill BORING # 1016

PROJECT: Geotechnical Exploration, Advanced Treatment Improv.-Additional Improv., Ft. Thomas, Kentucky JOB # 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-5

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. inches
804.6	SURFACE	0.3						
804.3	ASPHALT (3 ½ inches)	1.8		I	16/16/5	1	DS	7
802.8	Mixed brown moist stiff FILL, silty clay, with crushed limestone (base).	3.3		I	4/6/6	2	DS	12
801.5	Brown moist medium stiff SILTY CLAY, with oxide stains.							
	Bottom of test boring at 3.3 feet.							

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman BR / D-6

Surf. Elev. 804.6 ft. Hammer Drop 30 in. Rock Core Dia. -- in. Engineer LJC

Date Started 8/25/09 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 8/25/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER -- hrs. -- ft.
BACKFILLED 1 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: CH2M Hill BORING # 1017

PROJECT: Geotechnical Exploration, Advanced Treatment Improv.-Additional Improv., Ft. Thomas, Kentucky JOB # 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-5

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. Inches
804.5	SURFACE	0.5						
804.0	ASPHALT (5½ inches)	2.0		I	17/12/16	1	DS	18
802.5	Mixed brown moist stiff FILL, silty clay, with shale fragments.	3.5		I	6/8/9	2	DS	18
801.0	Mixed brown moist medium stiff FILL, silty clay, with limestone and shale fragments.							
	Bottom of test boring at 3.5 feet.							

Datum	MSL	Hammer Wt.	140 lbs.	Hole Diameter	5 in.	Foreman	BR / D-6
Surf. Elev.	804.5 ft.	Hammer Drop	30 in.	Rock Core Dia.	-- in.	Engineer	LJC
Date Started	8/25/09	Pipe Size	O.D. 2 in.	Boring Method	CFA	Date Completed	8/25/09

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER -- hrs. -- ft.
BACKFILLED 1 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

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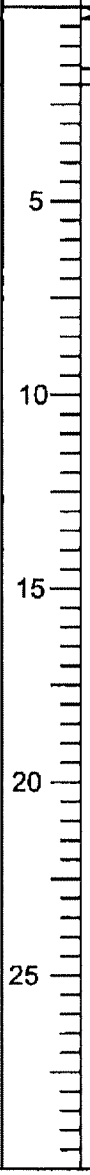
LOG OF TEST BORING

CLIENT: CH2M Hill BORING # 1018

PROJECT: Geotechnical Exploration, Advanced Treatment Improv.-Additional Improv., Ft. Thomas, Kentucky JOB # 080978E

LOCATION OF BORING: As shown on Boring Plan, Drawing 080978E-5

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. Inches
794.0	SURFACE	0.3						
793.7	ASPHALT (4 inches)	2.0		I	14/13/50	1	DS	3
792.0	Mixed brown moist stiff FILL, silty clay, with crushed limestone (base).				50/2"	2	DS	1
	Bottom of test boring at 2.0 feet.							



Datum	MSL	Hammer Wt.	140	lbs.	Hole Diameter	5	in.	Foreman	BR / D-6		
Surf. Elev.	794.0	ft.	Hammer Drop	30	in.	Rock Core Dia.	--	in.	Engineer	LJC	
Date Started	8/25/09		Pipe Size	O.D. 2	in.	Boring Method	CFA		Date Completed	8/25/09	

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

SAMPLE TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER -- hrs. -- ft.
BACKFILLED 1 hrs.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST - DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

CIVIL ENGINEERS

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LOG OF TEST BORING

CLIENT Kenton County Water District — BORING # 4

PROJECT Geotechnical Exploration, Ft. Thomas Water Treatment Plant, Ft. Thomas, Kentucky — JOB # 87343E

LOCATION OF BORING As shown on Drawing 87343E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	F
778.0	SURFACE	0.0						
773.5	Mixed brown slightly moist hard FILL, silty clay, shale, trace topsoil, limestone floaters, hairlike roots.			I	3/10/18	1	DS	10"
				I	9/8/7	2	DS	
771.7	Mixed brown and gray moist medium stiff FILL, silty clay and shale with limestone floaters. (CL)	4.5	5	I	5/6/4	3A 3B	DS	16
771.0	Mixed olive brown, trace gray moist stiff FILL, shale.	6.3 7.0		I	16/18/21	4	DS	16
768.5	Mixed brown and gray moist medium stiff FILL, shale and silty clay with limestone floaters.	9.5	10	I	3/15/25	5	DS	14
766.0	Mixed brown to dark brown moist medium stiff to stiff FILL, silty clay and topsoil with hairlike roots.	12.0						
763.0	Mixed brown moist medium stiff FILL, clay, trace gravel, sand and limestone floaters.	15.0	15	I	9/6/7	6	DS	18"
761.5	Brown, trace gray moist very soft highly weathered SHALE and thinly bedded LIMESTONE (bedrock).	16.5		I	7/18/50 /6"	7	DS	14
				I	20/37/31	8A 8B	DS	16
758.5	Brown to olive brown moist soft weathered SHALE and thinly bedded LIMESTONE (bedrock).	19.5	20	I	27/50/2"	9	DS	6
755.8	Olive brown and gray moist soft weathered SHALE and thinly bedded LIMESTONE (bedrock).	22.2		I	50/2"	10	DS	2"
	Bottom of test boring at 22.2 feet.		25					

Datum USGS — Surf. Elev. 778.0 Ft. — Date Started 9/7/87

Hammer Wt. 140 Lbs. — Hammer Drop 30 In. — Pipe Size O.D. 2 In.

Hole Diameter 5" — Rock Core Dia. — Boring Method CFA

Foreman MW — Engineer TWV — Date Completed 9/7/87

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLER TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None FT.
AT COMPLETION Dry FT.
AFTER HRS. FT.
BACKFILLED Immed. HRS.

BORING METHOD
HSA – Hollow Stem Augers
CFA – Continous Flight Augers
DC – Driving Casing
MD – Mud Drilling

*STANDARD PENETRATION TEST – DRIVING 2" OD SAMPLER 1' WITH 140 #, HAMMER FALLING 30", COUNT MADE AT 6" INTERVALS

CIVIL ENGINEERS

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LOG OF TEST BORING

CLIENT Kenton County Water District BORING # 204

PROJECT Geotechnical Exploration, Phase II Clarifier/Flocculator, Ft. Thomas, JOB # 89079E

LOCATION OF BORING As shown on Drawing 89079E-1 /Kentucky

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec.
778.0	SURFACE							
776.7	Mixed dark brown and brown moist medium stiff FILL, topsoil, trace shale and limestone floaters.	1.3		I	2/3/5	1	DS	13"
773.5	Mixed brown moist stiff FILL, silty clay, clay and shale with limestone floaters.	4.5	5	I	15/21/7	2	DS	9"
768.5	Mixed brown moist medium stiff to soft FILL, shale and silty clay, trace limestone floaters.			I	7/8/28	3	DS	16"
767.5	SANDSTONE LINER.	9.5 10.5		I	3/2/5	4	DS	16"
763.5	Mixed brown moist soft to medium stiff FILL, clay with shale fragments, limestone floaters and wet sand and gravel.	14.5	10	D		5	CA	
756.0	Brown, trace olive brown and gray moist very soft highly weathered SHALE and thinly bedded LIMESTONE (bedrock).			I	13/10/7	6	DS	16"
751.0	Brown to olive brown and gray moist soft weathered SHALE and thinly bedded LIMESTONE (bedrock).	22.0	15	I	50/25/2"	7	DS	8"
750.0	Gray moist soft SHALE and thinly bedded LIMESTONE (bedrock).	27.0		I	25/50/6"	8	DS	12"
		28.0	20		Note: Scale Change			
	Refusal and bottom of test boring at 28.0 feet.			I	50/6"	9	DS	6"
				I	50/6"	10	DS	6"
			25	I	50/6"	11	DS	6"
				I	50/6"	12	DS	6"
			30					
			35					

Datum USGS | Hammer Wt. 140 Lbs. | Hole Diameter 5" | Foreman JM

Surf. Elev. 778.0 Ft. | Hammer Drop 30 In. | Rock Core Dia. | Engineer TWV

Date Started 4/20/89 | Pipe Size O.D.2 In. | Boring Method CFA | Date Completed 4/20/89

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLER TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED 11.0 FT.
AT COMPLETION Dry FT.
AFTER 7 HRS. Dry FT.
BACKFILLED 7 HRS.

BORING METHOD
HSA – Hollow Stem Augers
CFA – Continous Flight Augers
DC – Driving Casing
MD – Mud Drilling

*STANDARD PENETRATION TEST – DRIVING 2" OD SAMPLER 1' WITH 140 #. HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

CIVIL ENGINEERS

G. J. Thelen & Associates, Inc.

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LOG OF TEST BORING

CLIENT Kenton County Water District — BORING # 301

PROJECT Geotechnical Exploration, Proposed Chlorine Building, Ft. Thomas Treatment Plant, Ft. Thomas, Kentucky — JOB # 89079E

LOCATION OF BORING As shown on Drawing 89079E-3

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec
779.4	SURFACE	0.3						
779.1	FILL, gravel.	2.0		I	6/8/12	1	DS	16
777.4	Mixed brown moist very stiff FILL, silty clay, trace topsoil and limestone fragments.	4.5		I	18/17/19	2	DS	15
774.9	Mixed brown slightly moist to moist very stiff FILL, silty clay with brown shale fragments.		5	I	7/5/9	3	DS	14
770.9	Mixed brown and gray slightly moist to moist very stiff to stiff FILL, silty clay and shale with limestone floaters.	8.5 10.0		I	8/35/6"	4	DS	12
769.4	SANDSTONE Liner.	10.5	10	I	25/9/12	5A 5B	DS	16
768.9	Brown moist very dense FILL, silty fine to coarse sand and gravel.	14.0		I	8/9/12	6	DS	15
765.4	Brown moist very soft highly weathered SHALE and thinly bedded LIMESTONE with clay seams (bedrock).		15	I	20/30/41	7	DS	18
758.4	Brown moist soft weathered SHALE and thinly bedded LIMESTONE (bedrock).	21.0	20	I	41/6"	8	DS	6
				I	25/50/6"	9	DS	12
	Bottom of test boring at 21.0 feet. Note: A Shelby tube sample was obtained in an offset hole from 1.0 to 2.0 feet. Recovery was 8 inches.		25					

Datum USGS — Hammer Wt. 140 Lbs. — Hole Diameter 5" — Foreman JM

Surf. Elev. 779.4 Ft. — Hammer Drop 30 In. — Rock Core Dia. — Engineer TWV

Date Started 5/26/89 — Pipe Size O.D.2 In. — Boring Method CFA — Date Completed 5/26/89

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLER TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None FT.
AT COMPLETION Dry FT.
AFTER ____ HRS. ____ FT.
BACKFILLED Immed. HRS.

BORING METHOD
HSA – Hollow Stem Augers
CFA – Continous Flight Augers
DC – Driving Casing
MD – Mud Drilling

*STANDARD PENETRATION TEST – DRIVING 2" OD SAMPLER 1' WITH 140 #. HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

CIVIL ENGINEERS

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LOG OF TEST BORING

CLIENT: Northern Kentucky Water Service District BORING # 1

PROJECT: Geotechnical Exploration, Laboratory Building, Ft. Thomas, Kentucky JOB # 980640E

LOCATION OF BORING: As shown on Drawing 980640E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. Inches
769.8	SURFACE	0.5		D	10/14/21	1A 1B	DS	13
769.3	TOPSOIL	2.3		I	4/7/9	2	DS	7
767.5	Mixed brown dry very stiff FILL, silty clay with limestone fragments and floaters.	4.5	5	I	30/50/6"	3	DS	12
765.3	Mixed brown moist soft to medium stiff FILL, silty clay and shale with limestone fragments and floaters.			I	35/50/6"	4	DS	12
756.8	Brown moist very soft highly weathered SHALE and thinly bedded LIMESTONE (bedrock).	13.0	10	I	50/6"	5	DS	6
754.3	Olive brown, trace gray moist soft weathered SHALE and thinly bedded LIMESTONE (bedrock).	15.5		I	38/50/6"	6	DS	12
	Bottom of test boring at 15.5		15 20 25	I	50/6"	7	DS	6

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman JM

Surf. Elev. 769.8 ft. Hammer Drop 30 in. Rock Core Dia. in. Engineer TWV/JSN

Date Started 9/11/98 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 9/11/98

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLE TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED 2.5 ft.
AT COMPLETION Dry ft.
AFTER 24 hrs. Dry ft.
BACKFILLED 24 hrs.

BORING METHOD
HSA– HOLLOW STEM AUGERS
CFA– CONTINUOUS FLIGHT AUGERS
DC – DRIVING CASING
MD – MUD DRILLING

STANDARD PENETRATION TEST – DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

CIVIL ENGINEERS

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LOG OF TEST BORING

CLIENT: Northern Kentucky Water Service District BORING # 2

PROJECT: Geotechnical Exploration, Laboratory Building, Ft. Thomas, Kentucky JOB # 980640E

LOCATION OF BORING: As shown on Drawing 980640E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. Inches
767.6	SURFACE	0.4						
767.2	TOPSOIL	2.0		D	10/30/6"	1A 1B	DS	10
765.6	Mixed brown and gray dry dense FILL, limestone fragments, some shale.			I	22/6"	2	DS	6
	Brown moist very soft highly weathered SHALE and thinly bedded LIMESTONE (bedrock).		5	I	30/6"	3	DS	6
				I	50/5"	4	DS	5
			10	I	35/30/3"	5	DS	9
753.6		14.0		I	50/3"	6	DS	3
	Brown to olive brown, trace gray moist soft weathered SHALE and thinly bedded LIMESTONE (bedrock).	15.5	15	I	50/6"	7	DS	6
752.1								
	Bottom of test boring at 15.5 feet.		20					
			25					

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman JM

Surf. Elev. 767.2 ft. Hammer Drop 30 in. Rock Core Dia. in. Engineer TWV/JSN

Date Started 9/11/98 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 9/11/98

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLE TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER 24 hrs. Dry ft.
BACKFILLED 24 hrs.

BORING METHOD
HSA– HOLLOW STEM AUGERS
CFA– CONTINUOUS FLIGHT AUGERS
DC – DRIVING CASING
MD – MUD DRILLING

STANDARD PENETRATION TEST – DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

CIVIL ENGINEERS

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LOG OF TEST BORING

CLIENT: Northern Kentucky Water Service District BORING # 5

PROJECT: Geotechnical Exploration, Laboratory Building, Ft. Thomas, Kentucky JOB # 980640E

LOCATION OF BORING: As shown on Drawing 980640E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. Inches
770.7	SURFACE	0.3						
770.4	TOPSOIL	2.5		I	9/15/15/5"	1	DS	16
768.2	Mixed brown dry very stiff to hard FILL, clay and shale with limestone fragments and floaters.	3.8		I	9/11/12	2A 2B	DS	14
766.9	Mixed dark gray to bluish gray moist medium stiff FILL, topsoil and clay with limestone fragments.(CH)	5.5	5	I	50/6"	3	DS	6
765.2	Brown moist very soft highly weathered SHALE and thinly bedded LIMESTONE (bedrock).		10					
	Bottom of test boring at 5.5 feet.		15					
			20					
			25					

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman JM

Surf. Elev. 770.7 ft. Hammer Drop 30 in. Rock Core Dia. in. Engineer TWV/JSN

Date Started 9/12/98 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 9/12/98

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLE TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER hrs. ft.
BACKFILLED Immed. hrs.

BORING METHOD
HSA– HOLLOW STEM AUGERS
CFA– CONTINUOUS FLIGHT AUGERS
DC – DRIVING CASING
MD – MUD DRILLING

STANDARD PENETRATION TEST – DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

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LOG OF TEST BORING

CLIENT: Northern Kentucky Water Service District BORING # 102

PROJECT: Geotechnical Exploration, Proposed Sodium Hypochlorite Building, Ft. Thomas, Ky. JOB # 990146E

LOCATION OF BORING: As shown on Drawing 990146E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. Inches
777.8	SURFACE	0.3						
		0.9						
777.5	ASPHALT.			I	9/6/8	1A 1B	DS	15
				I	5/7/25	2	DS	16
776.9	BASE, dense graded aggregate.		5	I	6/7/5	3	DS	13
				U		4	PT	7
	Mixed brown and gray moist medium stiff to stiff FILL, silty clay and pulverized shale with intact shale and limestone fragments and			I	35/5"	5	DS	2
			10	U		6	PT	7
760.3	floaters, trace sand (CL).			I	50/6"	7	DS	3
				I	10/11/8	8	DS	4
	Brown and gray wet very dense FILL, clayey sand and gravel with pieces of crushed limestone (possible remnant of old reservoir		15	I	19/21/11	9	DS	14
759.3	liner).	17.5						
		18.5		I	25/50/6"	10	DS	6
	Brown moist very soft highly weathered SHALE and thinly bedded LIMESTONE		20	I	30/50/6"	11	DS	12
755.8	(bedrock).							
	Olive brown, trace gray moist soft weathered SHALE and thinly bedded LIMESTONE	22.0		I	40/25/2"	12	DS	8
748.3	(bedrock).				NOTE: Scale Change			
	Gray moist soft SHALE and thinly bedded		25	I	50/5"	13	DS	5
747.3	LIMESTONE (bedrock).	29.5		I	50/5"	14	DS	5
	Split spoon refusal and bottom of test boring at 30.5 feet.	30.5	30	I	50/5"	15	DS	5

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman JM

Surf. Elev. 777.8 ft. Hammer Drop 30 in. Rock Core Dia. in. Engineer TWV

Date Started 4/10/99 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 4/10/99

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLE TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED 17.5 ft.
AT COMPLETION Dry ft.
AFTER hrs. ft.
BACKFILLED Immed. hrs.

BORING METHOD
HSA– HOLLOW STEM AUGERS
CFA– CONTINUOUS FLIGHT AUGERS
DC – DRIVING CASING
MD – MUD DRILLING

STANDARD PENETRATION TEST – DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

G. J. Thelen & Associates, Inc.
☐ 516 Enterprise Drive/Covington, Kentucky 41017-1595/606-341-1322/Fax 606-341-0832
☐ 2140 Waycross Road/Cincinnati, Ohio 45240-2719/513-825-4350/Fax 513-825-4756

LOG OF TEST BORING

CLIENT: Northern Kentucky Water Service District BORING # 103
PROJECT: Geotechnical Exploration, Proposed Sodium Hypochlorite Building, Ft. Thomas, Ky. JOB # 990146E
LOCATION OF BORING: As shown on Drawing 990146E-1

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRATA DEPTH feet	DEPTH SCALE feet	SAMPLE Cond	Blows/6"	No.	Type	Rec. Inches
778.8	SURFACE	0.3						
		0.8		D		1	CA	
778.5	ASPHALT.			I	9/35/4"	2	DS	6
778.0	BASE, crushed limestone.			U		3	PT	10
			5	I	10/19/9	4	DS	14
				U		5	PT	6
	Mixed brown, trace gray moist, locally slightly moist stiff FILL, silty clay and pulverized shale with intact shale and limestone fragments and limestone floaters.			I	7/25/1"	6	DS	2
766.8		12.0	10	I	7/14/21	7	DS	6
	Mixed brown moist soft FILL, silty clay and pulverized shale with limestone fragments and floaters (CL).	14.5		I	2/15/6"	8	DS	6
764.3			15					
	Mixed brown, trace gray moist stiff FILL, silty clay, pulverized shale and unpulverized shale with limestone floaters.			I	3/7/12	9	DS	13
758.3				I	4/7/11	10	DS	15
	SANDSTONE LINER.	20.5	20					
757.8		21.0		I	25/5"	11	DS	1.5
	Brown moist soft weathered SHALE and thinly bedded LIMESTONE (bedrock).			I	15/30/45/3"	12	DS	12
753.5		25.3	25					
	Bottom of test boring at 25.3 feet.			I	50/3"	13	DS	2

Datum MSL Hammer Wt. 140 lbs. Hole Diameter 5 in. Foreman JM
Surf. Elev. 778.8 ft. Hammer Drop 30 in. Rock Core Dia. in. Engineer TWV
Date Started 4/10/99 Pipe Size O.D. 2 in. Boring Method CFA Date Completed 4/10/99

SAMPLE CONDITIONS
D – DISINTEGRATED
I – INTACT
U – UNDISTURBED
L – LOST

SAMPLE TYPE
DS – DRIVEN SPLIT SPOON
PT – PRESSED SHELBY TUBE
CA – CONTINUOUS FLIGHT AUGER
RC – ROCK CORE

GROUND WATER DEPTH
FIRST NOTED None ft.
AT COMPLETION Dry ft.
AFTER hrs. ft.
BACKFILLED Immed. hrs.

BORING METHOD
HSA– HOLLOW STEM AUGERS
CFA– CONTINUOUS FLIGHT AUGERS
DC – DRIVING CASING
MD – MUD DRILLING

STANDARD PENETRATION TEST – DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

THELEN ASSOCIATES, INC.
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SOIL CLASSIFICATION SHEET

NON COHESIVE SOILS
(Silt, Sand, Gravel and Combinations)

Density	
Very Loose	- 5 blows/ft. or less
Loose	- 6 to 10 blows/ft.
Medium Dense	- 11 to 30 blows/ft.
Dense	- 31 to 50 blows/ft.
Very Dense	- 51 blows/ft. or more

Relative Properties	
Descriptive Term	Percent
Trace	1 – 10
Little	11 – 20
Some	21 – 35
And	36 – 50

Particle Size Identification		
Boulders	- 8 inch diameter or more	
Cobbles	- 3 to 8 inch diameter	
Gravel	- Coarse	- 3/4 to 3 inches
	- Fine	- 3/16 to 3/4 inches
Sand	- Coarse	- 2mm to 5mm (dia. of pencil lead)
	- Medium	- 0.45mm to 2mm (dia. of broom straw)
	- Fine	- 0.075mm to 0.45mm (dia. of human hair)
Silt		- 0.005mm to 0.075mm (Cannot see particles)

COHESIVE SOILS
(Clay, Silt and Combinations)

Consistency	Field Identification	Unconfined Compressive Strength (tons/sq. ft.)
Very Soft	Easily penetrated several inches by fist	Less than 0.25
Soft	Easily penetrated several inches by thumb	0.25 – 0.5
Medium Stiff	Can be penetrated several inches by thumb with moderate effort	0.5 – 1.0
Stiff	Readily indented by thumb but penetrated only with great effort	1.0 – 2.0
Very Stiff	Readily indented by thumbnail	2.0 – 4.0
Hard	Indented with difficulty by thumbnail	Over 4.0

Classification on logs are made by visual inspection.

Standard Penetration Test – Driving a 2.0" O.D., 1 3/8" I.D., sampler a distance of 1.0 foot into undisturbed soil with a 140 pound hammer free falling a distance of 30 inches. It is customary to drive the spoon 6 inches to seat into undisturbed soil, then perform the test. The number of hammer blows for seating the spoon and making the tests are recorded for each 6 inches of penetration on the drill log (Example – 6/8/9). The standard penetration test results can be obtained by adding the last two figures (i.e. 8+9=17 blows/ft.). Refusal is defined as greater than 50 blows for 6 inches or less penetration.

Strata Changes – In the column "Soil Descriptions" on the drill log, the horizontal lines represent strata changes. A solid line (————) represents an actually observed change; a dashed line (— — — —) represents an estimated change.

Groundwater observations were made at the times indicated. Porosity of soil strata, weather conditions, site topography, etc., may cause changes in the water levels indicated on the logs.

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Rock Weathering and Strength Classification Sheet

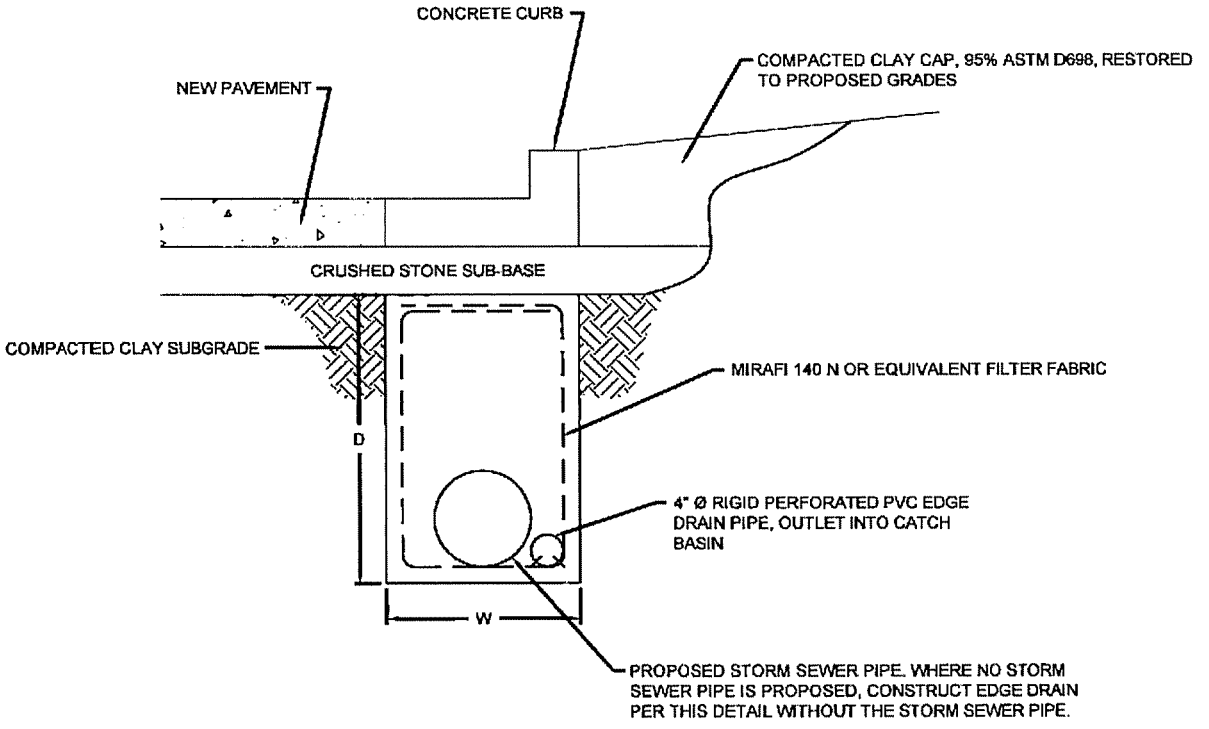
Rock Weathering

Descriptions	Field Identification
Unweathered	No visible sign of rock material weathering, perhaps slight discoloration on major discontinuity surfaces.
Slightly Weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than it its fresh condition.
Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.
Highly to Extremely Weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.
Residual Soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

Rock Strength

Descriptions	Field Identification	Strength (psi*)
Extremely Weak	Indented by thumbnail	40-150
Very Weak	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife.	150-700
Weak	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer.	700-4000
Medium Strong	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with a single blow of a geological hammer.	4000-7000
Strong	Specimen requires more than one blow of a geological hammer to fracture.	7000-15,000
Very Strong	Specimen requires many blows with a geological hammer to fracture.	15,000-36,000
Extremely Strong	Specimen can only be chipped with geological hammer.	>36,000

***Approximate range of unlaxial compressive strength**



W = TRENCH WIDTH. 12" MINIMUM WHERE 4" DIA. PERFORATED DRAIN PIPE ONLY, WITH NO STORM SEWER. STORM PIPE DIAMETER PLUS 2 FEET WHERE STORM SEWER IS PROPOSED.

D = TRENCH DEPTH BELOW SUBGRADE. 18" MINIMUM WHERE NO STORM SEWER IS PROPOSED. STORM SEWER DEPTH WHERE STORM SEWER IS PROPOSED

EDGE DRAIN DETAIL

THELEN ASSOCIATES, INC.
Geotechnical • Testing Engineers
1398 Cox Avenue / Erlanger, Kentucky 41018 / 859-746-9400
1780 Carillon Boulevard / Cincinnati, Ohio 45240 / 513-825-4350

EDGE DRAIN DETAIL

Client: CH2M Hill, Inc.		
Project: Geotechnical Exploration.		
Advanced Treatment GAC, Additional Site Improvements		
Location: Ft. Thomas, Kentucky		
Scale: 1" = 2'	Date: 9/30/2009	Drawing No.: 080978E-7

CASE NO: 2010-00093

CONTAINS

LARGE OR OVERSIZED

MAP(S)

RECEIVED ON: February 26, 2010