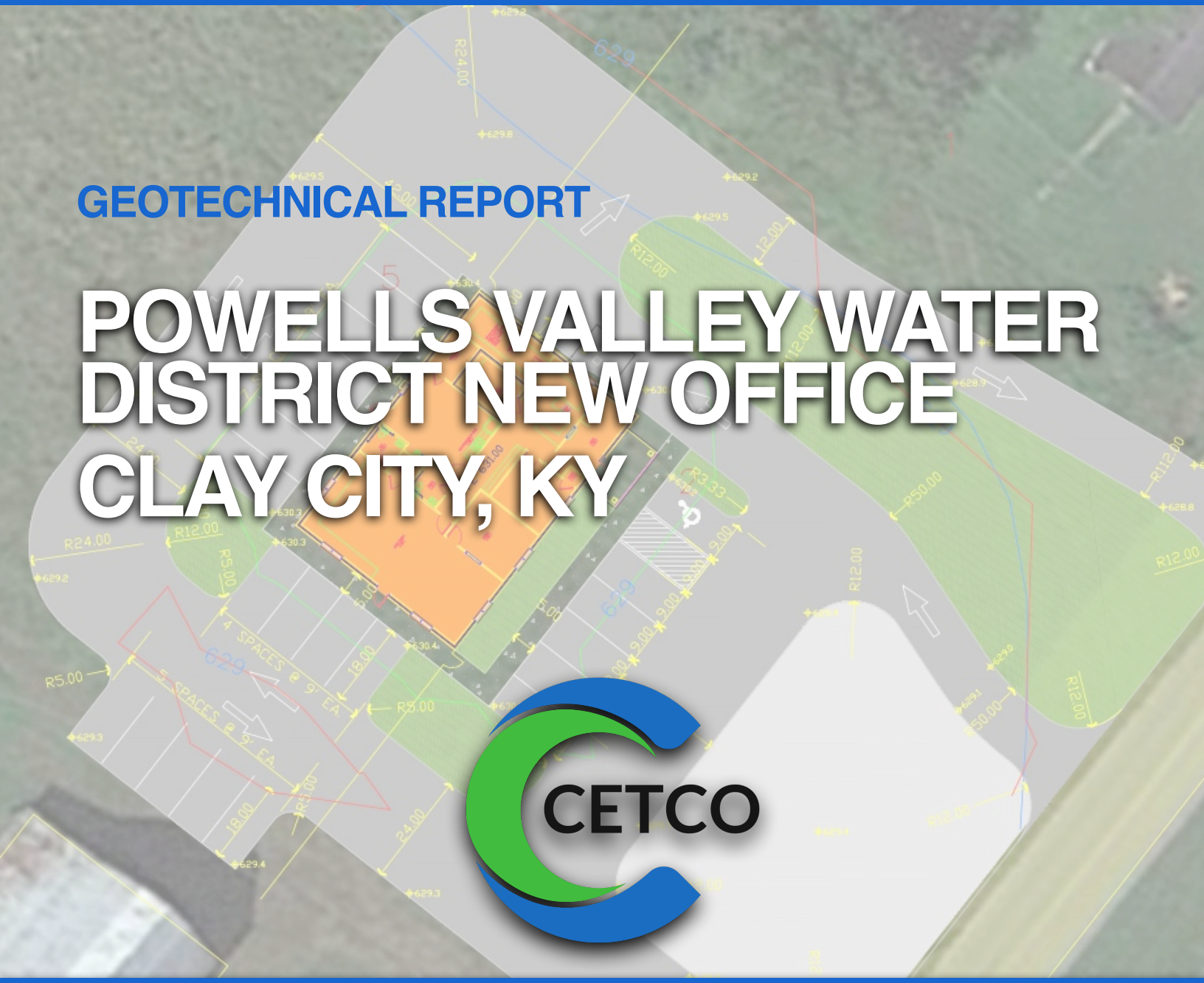
September 21, 2023

GEOTECHNICAL REPORT

POWELLS VALLEY WATER DISTRICT NEW OFFICE CLAY CITY, KY



CETCO

Cooke Engineering and Testing Company

September 21, 2023

Powells Valley Water District
Sent % MSE of Kentucky, ATTN: Mr. Eric Loy, RA
via email: eloy@mselex.com

Subject: **Geotechnical Report**
Powells Valley Water District New Office Building
Clay City, Kentucky
CETCO Project No. 1776-23-0123

Dear Mr. Loy:

CETCO appreciates the opportunity to provide our services to you and your project. As follows, we are providing our geotechnical report. Also, please note the report Appendix which contains many detailed findings as well as our standard of care for providing our services.

We appreciate the opportunity to provide our geotechnical services to you and the project team. Please do not hesitate to contact us for questions or comments about the information contained herein.

Cordially,
CETCO

Joseph S. Cooke, P.E.
Principal
Licensed KY 21244

Attachments: Geotechnical Report and Appendix
cc: Mr. Scott Taylor, PE w/MSE

Cooke Engineering and Testing Company

TABLE OF CONTENTS

Powells Valley Water District, New Office Building

CLAY CITY, KENTUCKY

GEOTECHNICAL REPORT SUMMARY

We provided our services in general accordance with our previous discussions and our proposal number 1776-23-0226, dated August 21, 2023 as approved by your office. CETCO has consulted with your office and discussed the need for CETCO to provide geotechnical services including sampling and exploration with soil test borings, a site field services by our office, lab testing and analysis and providing a geotechnical report. These services included providing our opinion of the conditions encountered for the purpose of design and development of a vacant site into a potential new office building project. The site is located off of 11th Street in Clay City, Kentucky. Provided information indicates a “footprint” for the building of less than 3,000 square feet. The building will be single story with surrounding parking, driveway and a “drive through” lane. This introductory section, which has previously been discussed with your office, provides a brief summary for quick reference. The report that follows provides much greater details for design and construction purposes.

In general, we encountered the typical, sandy soil overburden found in Clay City (most areas near the river). Free water was encountered in all borings, ranging in depth from about 4 to 6 feet. Below the sandy soil overburden, black shale bedrock was encountered at about 6 to 7 feet deep at the site. The native soils were typically firm down to about 2 feet deep, then becoming soft.

The site is suitable for the development. We believe shallow spread footings can be used for proposed building. Conventional slab-on-grade floors would also be suitable for most new building types.

The primary concerns for the site are the “normal” risks for areas near the river in Clay City. This include: shallow water, soft soil condition (mostly due to water) and construction in sandy soils. Normal construction and planning practices for the area are expected. Details for these issues and recommendations for design and construction as well as our other recommendations are discussed in the report.

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1 PROJECT BACKGROUND

1.1 CETCO SCOPE OF SERVICES

Our scope of services included review of provided drawings, exploration of the proposed site with soil test borings at select locations and laboratory testing and geotechnical analysis. After we completed our reviews, field work and laboratory testing, we are issuing this geotechnical report as follows.

1.2 PROVIDED INFORMATION

We were provided information for the project as follows:

Provided Document	Source
The provided sketch shows the potential footprint/building layouts on the site.	MSE
Civil site plan showing the building and a proposed pavement layout (parking and drives)	MSE

The following information summarizes our understanding of the project conditions

Condition	Specifics
Building/Structure Information	The building will likely be less than 3,500 square feet in size and would be single story. The framework will likely be a slab-on-grade floor, with stud walls/joist roofing.
Site Grading	The site is relatively flat. However, at least 2 feet of new fill expected to “raise” the site elevations.
Foundations/Floor Slabs	At this stage in the project, foundation loading conditions have been assumed as: less than 25 kips for any isolated columns and less than 2 kips per linear foot for continuous footings. Floor slab loading would be expected to be less than 250 pounds per square foot.

If any of the aforementioned information is incorrect or requires modification, please let CETCO know. Changes to our reporting, recommendations and opinions may be required.

1.3 PUBLISHED SITE AND AREA INFORMATION

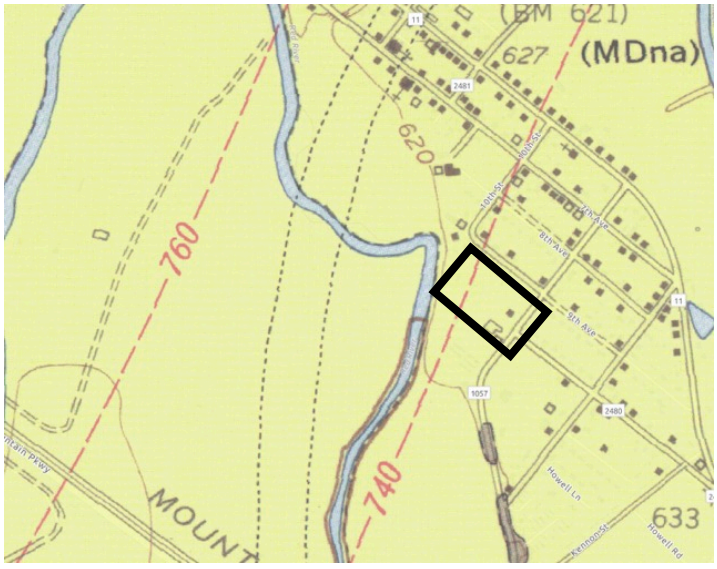
We have reviewed the following published/public domain site information.

AREA TOPOGRAPHY AND PHYSIOGRAPHY

The site is located in the “Eastern Kentucky Coalfield Region” of Kentucky is dominated by forested hills and highly dissected by V-shaped valleys. These areas can have resistant Pennsylvanian-age sandstones with steep and generally stable slopes, but also have soft, shale bedrock areas with “unstable” slopes.The southern boundary of this physiographic region in Kentucky consists of knobs which consist of hundreds of steep sloping cone shaped hills. Elevations within the site vicinity generally ranged from 600 feet along the Red River to 800 feet along ridges. The specific site topography is relatively flat with elevations approximately ranging from 620-628 feet.

SITE GEOLOGY AND AERIAL MAPPING

The Kentucky Geologic Survey (KGS) public information was reviewed including the USGS Clay City Geologic Quadrangle. The site is underlain by a thin veneer/surface layer of alluvial material, further underlain by the New Albany Shale Formation. The alluvium is mostly clay, silt and shale with some gravel. The New Albany is a dark gray to black shale that weathers to brownish coloring. Our borings confirmed the mapping. The New Albany Shale contains thin layers to pyretic materials that can be prone to swelling (oxidizing of the pyretic sulfur to form crystals) if exposed to both moisture and oxygen.



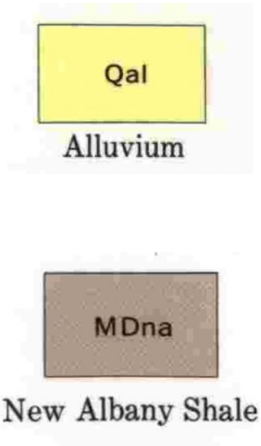


Image from the KGS website showing Original GQ Image: Site location is the black rectangle.

AERIAL MAPPING

Aerial information back as far as 1995 was readily available for the site. Images showing site progression. The photo below on the left is the aerial from 1995, showing the existing barn south of the site, with what appears to be a gravel road near the northwest corner of the outlined rectangle. In the 2004 aerial, there is a gravel road leading off of 11th street that runs along the border of the property just east of the barn and is shown in the 2008 aerial below. The 2008 aerial also indicated that a concrete structure was built near the northwestern property border. From 2008 to 2019 the site appears to have minimal changes, where the gravel road appeared to be unused and some vegetation surrounding the concrete structure. The most recent aerial shows current site conditions where the vegetation around the concrete structure was removed and few trees near 11th street were removed also. The white outline represents approximate property boundaries and the yellow outline indicates the approximate office building location.

1995 : Aerial from Google Earth

2008 : Aerial from Google Earth

2022 : Aerial from Google Earth

SITE SOIL SURVEY MAPPING

The Soil Survey of the site area was also reviewed. Issues affecting the site development included: shallow depth to saturated zone and shrink/swell of soil. The shrink/swell likely deals with potential New Albany Shale materials at bedrock depths. We are providing recommendations to address these issues. Also, the soil survey lists the some of the site as having “high risk” for corrosion of steel. Typically, the main risk for corrosion would be for steel reinforcement in concrete foundations and slabs. The primary means to address this risk is to specify at least 2 inches of concrete cover over all steel reinforcement for concrete exposed to soil.

2 CETCO FINDINGS

We provided a site and area reconnaissance, logged soil test borings and explored the site using those borings. The following sections discuss our findings. Mr. Hunter Hawkins, staff geologist, provided our field services including a site reconnaissance and logging of the borings in the field, during the exploration on September 1, 2022. Mr. Joe Cooke, PE, also conducted a site visit and observed recovered samples.

2.1 CURRENT SITE SURFACE CONDITIONS AND OBSERVATIONS

The site is located adjacent to 257 11th Street in Clay City, Kentucky. Upon turning off of 11th street there is a gravel entrance leading you to the vacant property. The site is a relatively flat open grassy area with minimal elevation changes at the proposed building location which is located at the southern portion of the property. The property is rectangular starting from 11th street and extending just before the Red River. Just before the red river is a rectangular concrete structure approximately 1000 square feet in size. One barn is located just southwest of the site edge, near to where the proposed new office building location. The property is bordered by tree-lines east and north of the site, with the Red River beyond the northern tree line and residential areas east of the site.

The ground surface appeared to be “firm” and did not appreciably rut under the weight of the drill rig during our drilling operations. The site appears to drain well, as the weather conditions prior to drilling drilling included rainy days, but no large-scale ponding of water due to the rain was observed and minimal muddy conditions were observed. However, several “crawdad” holes were observed on-site, which is usually an indicator of soft soils and wet conditions near the surface. Also, at an area near 11th Street, we observed an isolated “bushy” area with dense vegetation and a plastic truck bed liner and some other debris. Possible debris lies within the vegetation (see photos).

The following pages show photos at the site at the time of our field work.

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Project Photos

Description	Photo
Showing southwest section of the site, showing barn just off site, facing southwest.	
Example view of proposed building pad area, showing treelined with houses in the background. Facing northeast.	

Project Site Photos (cont.)

Description	Photo
Showing open, grassy area of he northern sections of the site, facing northwest.	
Example view at boring B-5 location in the proposed parking areas with 11th street in the background. Facing south.	

Project Site Photos (cont.)-1

Description	Photo
Showing example “crawdad” hole.	
Debris and “bushy” area. Possible further debris inside vegetation. Located near 11th Street.	

2.2 SUBSURFACE INFORMATION SUMMARY

A total of five (5) soil test borings were utilized to explore the subsurface conditions at the site. Three were located in the proposed building area and two were located in pavement areas. The borings were drilled in locations to provide an overall indication of the site subsurface conditions as well as in areas that within the provided plan's building location. The boring location plan in the appendix shows the approximate drilling locations.

SUBSURFACE CONDITIONS: At our sampling locations, we encountered topsoil overlying generally gray and brownish shades of sandy soils. The upper 1 to 2 feet of soil appears to be "sandy clay". Below this upper strata, the material becomes much more sandy, soft/loose and wet, and these extend down to the top of shale bedrock. The soils were generally firm in the upper strata, but soft to very soft below about 2 feet deep. Below is a table summarizing the soil conditions at the site. Detailed findings are in the Appendix boring logs and laboratory testing pages.

Strata	Thickness	Notes
Topsoil	4 to 7 inches	
Native soils: upper strata of brownish, sandy lean clay. Generally firm and moist.	About 2 feet	
Native soils: gray, with some brown and orange, sand and clay mixture. Generally soft/loose and very moist to wet.	About 3 to 6 feet thick	
Weathered black shale bedrock to competent black shale.	NA	

Auger refusal was encountered in all six borings, ranging from 6.7 to 7.8 feet deep. Refusal material is interpreted at the top of black shale bedrock. The table below shows depth to auger refusal (i.e., top of bedrock).

Boring Number	Depth to auger refusal (feet)
B-1	7.8
B-2	7.2
B-3	6.9
B-4	6.7
B-5	7.3

GROUNDWATER CONDITIONS: Free water or “wet” conditions were encountered in all 5 borings. The site area is part of the alluvial valley for the Red River and contains larges areas of sandy soils. As such, shallow wet/water conditions are expected and are widespread. **Depth to water in our borings ranged from 4.5 to 6.5 feet from the existing top of ground.** Area geologic mapping also shows water wells with similar depths to ground water.

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3 OPINIONS AND DISCUSSION

SUMMARY: In general, the project site is suitable for the proposed new development and site improvements. This includes the use of shallow spread footings and conventional building slab-on-grade floors.

3.1 PRIMARY GEOTECHNICAL ISSUES

The following issues are our opinion of the primary geotechnical-related issues at the site. Other issues are likely present, but we believe the following represent the greatest impact to the project budget, schedule, design and construction. Our recommendations address these issues.

- Shallow water/wet conditions and soft/loose soils
- Sandy soil conditions
- Shallow bedrock and swelling shale

Shallow water/wet conditions and soft/loose soils

The entire site is prone to shallow water conditions. “Crawdad” holes were seen on numerous areas, the geologic and soil mapping states “shallow water” and all of our borings encountered water/wet conditions. ***These wet conditions appear to be prevalent at or near bottom of footing elevations. Dewatering measures such as long-term (over night or more) pumping should be expected to obtain sufficient dry conditions for foundation concrete placement.***

Wet conditions also create soft/loose soils. This means some undercutting of foundations should be expected as well as some areas “failing proof-rolling” and requiring some undercutting. ***However, CETCO should be retained to inspect foundation bearing conditions as well as observing proof rolling to avoid excessive undercutting. Undercutting to find “solid” underlying material may be futile as the conditions seem to get softer with depth. Select undercutting and widening of foundations as well as the use of geo-grid under pavements/slabs may be the best solution for dealing with soft conditions.***

Sandy soil conditions

The entire site is underlain by alluvial soils, most of which are sandy. Sandy soils tend to slump in excavation and also tend to "fluff" when left open to the air. ***Foundation excavations will likely cave-in and wider than normal excavation (i.e., additional concrete) should be expected***. Also, excavations deeper than 4 feet will require a trench box to remain open. Lastly, sandy soils tend to hold water.

Shallow Bedrock and Swelling Shale

Our borings encountered the top of bedrock from about 6 to 7 feet deep across the site. Excavations at or near this depth will encounter shale bedrock. The upper 2 feet or so of the bedrock appears to be somewhat soft and could likely be removed with a large excavator. Below this elevation "rock removal" techniques such as hoe-ramming may be needed for excavation.

Of note, the shale bedrock material is New Albany Shale. This material can be prone to severe, quick and excessive swelling when exposed to weathering conditions (air and water). ***For any rigid structure's excavation that comes in contact with this material, CETCO should be contacted for guidance to minimize the risk of severe swelling in that area.***

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4 RECOMMENDATIONS

The following recommendations are provided to assist in the planning, design and construction of the project.

4.1 SITE PREPARATION

We recommend that site grading should take place between about late April to early November. Earthwork taking place outside this time period will likely encounter wet conditions and weather conditions that will provide little to no assistance with drying the soils. Additionally, the following bulleted items are critical to prepare the site for earthwork and additional construction.

- Topsoil and organic materials should be removed (stripped) from the construction area and all structural fill areas. These materials should be wasted from the site or used as topsoil in landscape areas;
- CETCO should be present during stripping to avoid over-stripping. Over-stripping may unnecessarily expose very soft soils at the site, creating excessive unstable conditions;
- Areas ready to receive new fill should be proofolled with a loaded dump truck or similar equipment judged acceptable by CETCO;
- Proofrolling should not be performed on wet subgrade. If possible, perform proof rolls after suitable dry weather periods of time;
- ***CETCO should determine amounts of undercutting (if any)*** for any area which pumps or ruts. CETCO should also determine acceptable backfill materials and backfill methods. In general any backfill should be accomplished in general accordance with section 4.2;
- Remove deleterious materials or materials that are unsuitable for use in supporting the overlying new fill. Minimal debris was encountered in our borings, but ***some debris was observed at the top of ground.*** The backfill should be consistent with the requirements listed in section 4.2;
- CETCO should observe the proofrolling operations and make recommendations for any unstable or unsuitable conditions encountered.

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4.2 EARTHWORK

Before new fill construction, representative samples should be obtained of the proposed fill material to determine the moisture-density and overall classification of the material. The tests also would assist in determining if the material is suitable for use as structural fill.

The site is somewhat “level/flat”, but we understand that 1 to 3 feet of new fill may be needed to “raise” the building pad and/or site area. As such, we are providing the following for any mass earthwork/filling. After the subgrade has been approved to receive new fill, the fill may commence with the following procedures and guidelines recommended:

Mass Earthwork

- Based on our observations and laboratory testing, the on-site soils appear to be suitable for use as structural fill;
- Fill placement guidelines:
    - Structural fill should be placed in maximum 8-inch thick loose lifts;
    - Maximum particle size of the soil should be limited to 8 inches in any dimension;
    - Materials should have a plasticity index (PI) of less than 30.
    - ***DO NOT USE NEW ALBANY SHALE (OR SIMILAR) AS NEW FILL FOR THE BUILDING PAD AREA.***
- Quality control testing guidelines:
    - Density testing of newly placed clay soils should be performed. The rate of testing should be at least 3 per lift and at least one per 10,000 square feet of soil placement. Soil should be compacted to at least 95 percent of standard Proctor (ASTM D698) maximum dry density. Moisture content should be from minus 1 to plus 3 percent of optimum moisture content (range is such due to moderately high plasticity of the on-site clay soils);
    - Soil should never be placed “dry” (dusty). CETCO should observe fill placement to determine acceptable soil moisture;
- ***Due to a shallow water table, no vibration should be used on new mass fill.***
- Observation of fill “stability” is critical. The roller and earthwork equipment traversing over the new fill should be observed to document minimal movement occurs. This includes sheepsfoot roller action observed to ensure the compactor is “walking out” of each lift;
- CETCO should observe and document fill placement and compaction operations.

Backfill Construction

These materials are placed in more confined areas than mass earthwork materials and therefore cannot be placed in full compliance with the previous recommendations. The following are general recommendations for backfill areas:

- Gravel/granular materials are recommended for confined fill areas;
- Fill lift thicknesses will vary dependent on compaction equipment available and material types, but in no case should exceed 8 inches;
- For crushed stone/aggregate backfills in trenches or wall backfill, the lift thickness should not exceed 4 inches;
- ***Again, due to shallow water tables on site, no vibration should be used on backfill areas;***
- Observation of stability and moisture should be similar to those mentioned previously;
- CETCO should provide addition recommendations for backfill.

Again, we recommend that site grading be started in the period from about late April to about November in order to prevent additional undercutting due to wet conditions. Drying of the site soils during other portions of the year is typically difficult.

Site Drainage

Site drainage (water flow into, along and from the site) is key to minimize damaging effects of water flow. Excess water ponding can destabilize soils. Excessive water flow can erode soils and destabilize soils, especially at or near slopes.

For shallow groundwater seepage (less than 5 feet deep or so), the water encroaching upon construction excavations can be removed by placing a sump near the source of seepage and then pumping from the sump. ***Heavy seepage and a shallow ground water table are expected (about 3 feet or shallower from current top of ground).*** Overnight (or longer) pumping may be required to obtain sufficiently dry excavations for placement of concrete in footings or other deeper excavations. If more excessive means of dewatering are needed, then the geotechnical engineer should be contacted.

The following are general guidelines for site drainage.

- For all earthwork operations, positive surface drainage is prudent to keep water from ponding on the surface and to assist in maintaining surface stability;
- The surface should be sealed prior to expected wet weather. This can usually be accomplished with rubber-tired construction equipment or a steel-drum roller;
- During construction, water should not be allowed to pond in excavations or undercutting will likely be required;
- During the life of the project, slope the subgrade and other site features so that surface water flows away from the site structures;
- **Future building structure roof drains should be piped into proper storm drainage systems (critical for managing the risk of karst/sinkhole future formation);**
- The site is relatively flat and normal dewatering such as brief pumping and open channel flow (ditches) may prove futile.

4.3 SITE SEISMIC DESIGN

The Kentucky Building Code (KBC), as updated was reviewed to determine the Site Seismic Classification. Based on our review of geologic data, our experience, and subsurface conditions encountered, we recommend a Seismic SITE CLASS "B" for the site.

A detailed geotechnical earthquake engineering analysis was not performed. However, based on a review of published literature and our experience with similar subsurface conditions, we believe the potential for slope instability, liquefaction (sandy soils at the site are very clayey), and surface rupture due to faulting or lateral spreading resulting from earthquake motions is low.

4.4 FOUNDATIONS

The following recommendations are also based on the previously described project information, typical single story commercial building types, the subsurface conditions encountered in the borings, the results of laboratory testing, empirical correlations for the soil types encountered, and CETCO's analyses and experience.

Shallow Spread Footings

The site conditions encountered and/or newly/properly compacted engineered fill can support the proposed single story building with shallow spread footings. ***A maximum allowable net***

bearing pressure of 1,500 pounds per square foot (psf) is recommended for footings bearing on firm or better native soils or compacted engineered fill. Additional design considerations for project foundations are outlined as follows:

- Design footings with a minimum dimension of 24 inches wide;
- Place all exterior footing bottoms to at least 24 inches below finished exterior grade (frost depth for Powell County);

Shallow Foundation Construction Considerations

The soils encountered in this exploration may lose strength if they become wet during construction. Therefore, we recommend the foundation subgrades be protected from exposure to water. The following guides address protection of footing subgrades and our recommended remediation for any soft soils encountered.

- Bearing condition evaluations must be conducted using dynamic cone penetration (DCP) and hand auger borings at all footing locations. ***Soft zones are expected*** and CETCO can determined the depth of undercutting or "width" of excavation needed to adjust to such soft conditions. ***Avoid excessive undercutting/depths due to likely shallow water/wet conditions.***
- To protect against "moisture loss" or "soil drying" during warmer months, foundation concrete should be placed the same day as excavation.
- Remove any soils disturbed by exposure prior to foundation concrete placement.
- Level or suitably bench the foundation bearing area.
- Remove loose soil, debris, and excess surface water from the bearing surface prior to concrete placement.
- Sandy soils and a shallow water table are expected. ***The excavations will likely slough and wider than normal trenches would be expected (i.e., additional spoils and concrete). Overnight pumping may be needed to achieve sufficiently dry foundation excavations for concrete placement.***
- CETCO must observe all foundation excavations and provide recommendations for treatment of any unsuitable conditions encountered.
- CETCO should be retained to evaluate actual conditions.

4.5 FLOOR SLABS

Normal conventional type slabs can be supported by engineered fill soils or native/existing soils. Again, the areas should be proof rolled at the direction of CETCO prior to slab gravel base placement. Further, the subgrade should be prepared according to the recommendations contained within this report. The following features are recommended as part of the floor slab construction:

- ***Due to shallow water conditions, a vapor barrier of at least 20 mil thickness should be used.***
- If possible, avoid construction of slabs during the hottest/driest months (typically July, August or September) due to potential “dry soil” conditions.
- Keep the crushed stone or gravel moist, but not wet, immediately prior to slab concrete placement to minimize curling of the slab due to differential curing conditions between the top and bottom of the slab.
- Retain CETCO to review the actual subgrade conditions prior to slab construction and make recommendations for any unsuitable conditions encountered.
- If soft conditions are encountered, undercutting may prove futile and a better option may be to use a geo-grid to bridge the soft soils. CETCO would provide those recommendations upon observation of the conditions.

4.6 PAVEMENT RECOMMENDATIONS

The heaviest/most severe traffic for the site would likely be concrete or delivery trucks and fork lifts during construction. The project should include additional budget for some undercut and replacement for the lay-down area for materials and haul paths for such traffic. Also, the construction entrance road will likely need double the normal thickness of gravel.

For the final pavement, light duty (passenger car traffic) areas of parking as well as medium duty (passenger cars and delivery trucks) are assumed for the site. The most significant areas of traffic are the main entrances and main intersections of the parking lot and we have considered these to be the “medium duty” areas. Please note, we are also providing recommendation for dumpster areas in the last portion of this section.

If the site areas “pass” a proof roll, the subsurface materials appear to be suitable to support the new pavement areas. Adequate soil/subgrade support is critical for any pavement area. Please refer the Earthwork section of this report for subgrade preparation. Prior to stone base

placement we recommend an additional proofroll of the subgrade should be performed to verify subgrade conditions. Recommendations for undercutting/repair of the subgrade can be made at that time by CETCO. Please note: ***the site has a shallow water table and widespread shallow soft conditions***. Undercutting to find "hard" ground may proof futile and often the best way to manage soft conditions is to use geo-grid under the gravel sections. ***We recommend budgeting at least one roll of Tensar InterAx geo-grid for the project.***

We have have assumed a CBR of 3 for the area. We have also assumed a 15 year life with the "relatively low" EAL.

Adequate drainage and slope of the pavement subgrade and pavement section should be provided to promote adequate drainage. Edges of the pavement should be provided a means of water outlet by extending the aggregate base course through to side ditches or providing drain pipes and weep holes at catch basin walls.

Light Duty Parking

Based on the above traffic and design parameters and our experience with similar projects, we recommend using the following pavement section for parking lot areas:

Parking Pavement Sections

Component	Parking Lots Only
Surface Course	1
Asphalt Base Course	2
Base Material (DGA)	8

The asphalt should be mixed, placed, and compacted in accordance with Kentucky Transportation Cabinet Standard Specifications. Also, the dense graded aggregate (DGA) should be placed and compacted in accordance with KyTC Specifications.

Medium Duty: Entrances, and Intersections Areas

The main entrances and intersection areas will received the bulk of heavy forces, twisting and turning and large-scale stopping and starting that typically wear down pavement areas and create failures in pavement sections. For these areas, we recommend a thicker pavement section (increase the stone by 2 inches ***OR*** the base asphalt by 1 inch), or alternatively the areas can add a layer of Tensar InterAx geogrid.

Dumpster Area

The dumpster pad and dumpster unloading area should be concrete pavement. At least 6 inches of concrete thickness should be used overlying at least 6 inches of compacted DGA base stone. Extend the concrete in the unloading area to at least 2 feet beyond the full length of both axles of conventional garbage trucks and at least 3 feet beyond the conventional width (each side).

4.7 POST-REPORT GEOTECHNICAL CONSULTING

CETCO services as “geotechnical engineer of record” include answering questions pertaining to the materials presented in this report and the appendix. However, if conditions arise during construction that are different than those encountered during our exploration or if additional recommendations are needed, CETCO should be retained to provide that guidance. Construction observation and testing are beyond the typical scope of the geotechnical engineer, but are essential to completing the geotechnical engineer’s anticipated completion of their recommendations. CETCO should always be contracted as the testing/inspection firm for any project that applies their geotechnical report information. This always saves time, risk and project costs.

5 NOTES ON THE REPORT

The assessment of site environmental conditions or the presence of contaminants in the soil, rock, surface water or groundwater of the site was beyond the scope of this exploration.

The recommendations provided are based in part on project information provided to us and they only apply to the specific project and site discussed in this report. If the project information section in this report contains incorrect information or if additional information is available, you should convey the correct or additional information to us and retain us to review our recommendations. We can then modify our recommendations if they are inappropriate for the proposed project.

Regardless of the thoroughness of a geotechnical exploration, there is always a possibility that conditions between borings/test pits will be different from those at specific boring/test pit locations and that conditions will not be as anticipated by the designers or contractors. In addition, the construction process may itself alter soil conditions. Therefore, experienced geotechnical personnel should observe and document the construction procedures used and the conditions encountered. Unanticipated conditions and inadequate procedures should be

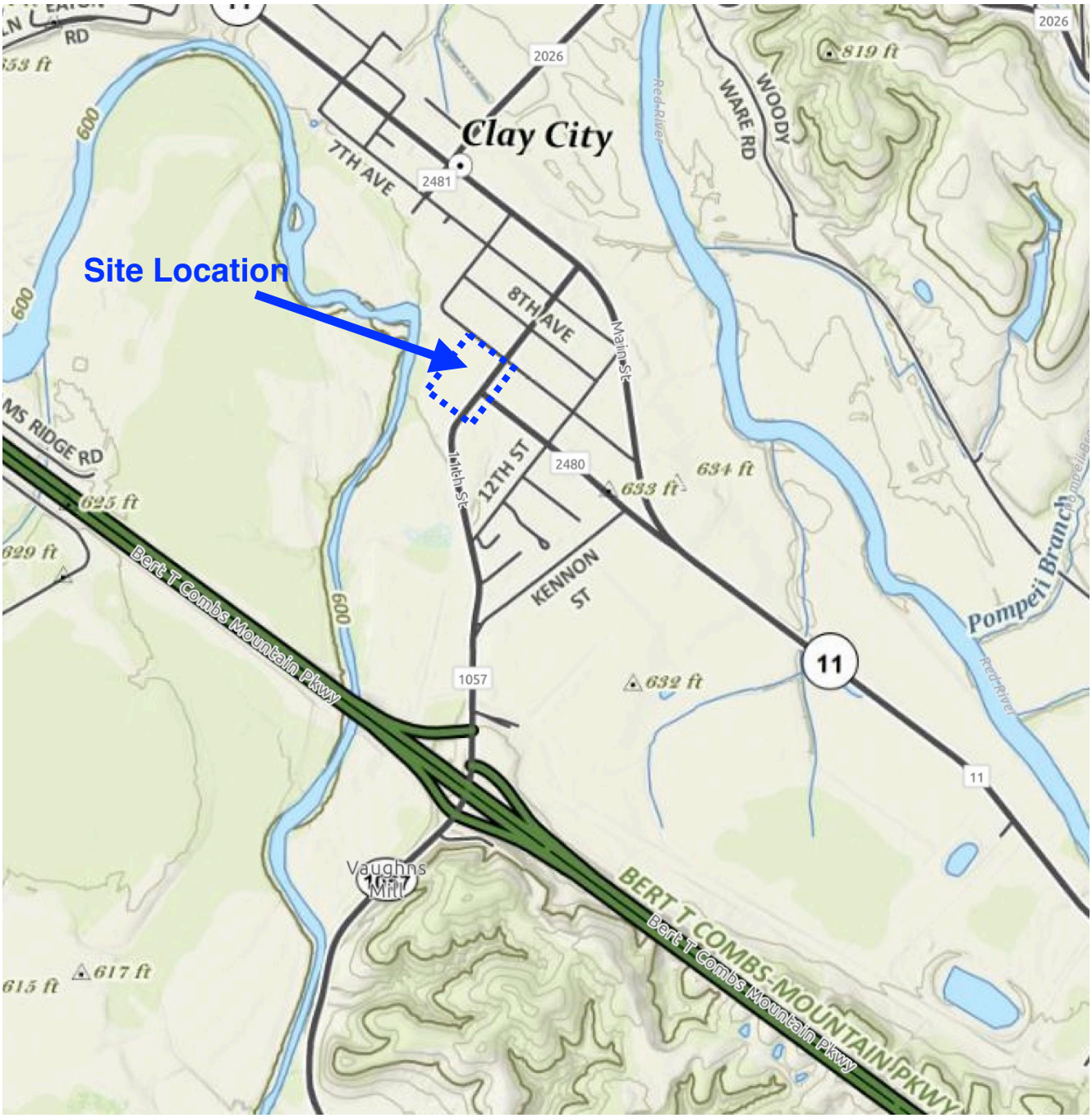
reported to the design team along with timely recommendations to solve the problems created. We recommend that the owner retain CETCO to provide this service based upon our familiarity with the project, the subsurface conditions and the intent of the recommendations.

We recommend that this complete report be provided to the various design team members, the contractors and the project owner. Potential contractors should be informed of this report in the "instructions to bidders" section of the bid documents. The report should not be included or referenced in the actual contract documents.

We wish to remind you that our exploration services include storing the samples collected and making them available for inspection for 30 days. The samples are then discarded unless you request otherwise.

APPENDIX

SITE LOCATION PLAN
BORING LOCATION PLAN
TEST BORING LOGS
FIELD STANDARDS
LABORATORY TESTING
LABORATORY STANDARDS



Site location plan adapted from Kentucky Geological Survey, with further adaptations from CETCO professionals.

CETCO, PLLC
624 Wellington Way
Lexington, KY 40515
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SITE LOCATION PLAN
for Powells Valley Water District Office Building

Clay City, Kentucky

CETCO Project: 1776-23-0123
Date: September 19, 2023
Drawn by: Hunter Hawkins
Checked by: Joe Cooke, PE
Drawing: 1 of 1

N

Boring location plan adapted MSE of Kentucky, with further adaptations from CETCO professionals.

Legend

Boring location, B-X

CETCO, PLLC
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BORING LOCATION PLAN
Powells Valley Water District - Office Building

Cave City, Kentucky

CETCO Project: 1776-23-0123
Date: September 19, 2023
Drawn by: Hunter Hawkins
Checked by: Joe Cooke, PE
Drawing: 1 of 1

CETCO
624 Wellington Way
Lexington, KY 40503
Telephone: 859-475-3933

BORING NUMBER B-1

CLIENT Powells Valley Water District
PROJECT NAME Powells Valley Office Building
PROJECT NUMBER 1776-23-0123
PROJECT LOCATION Clay City, Kentucky
DATE STARTED 9/1/23 **COMPLETED** 9/1/23
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR Strata Group
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING --- Water table at 6.5 feet
LOGGED BY Hunter Hawkins **CHECKED BY** Joe Cooke, PE
AT END OF DRILLING ---
NOTES Mostly Sunny, 70's
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0.0		TOPSOIL (4")					
		Brownish gray sandy LEAN CLAY (CL), moist, FIRM	SPT S-1	83	2-2-2 (4)		
2.5		Brownish gray sandy ALLUVIUM (SC), very moist, SOFT	SPT S-2	94	1-1-1 (2)		
		Water table at 6.5 feet					
5.0			SPT S-3	100	1-2-2 (4)		
		Brown sandy ALLUVIUM (SC), with some gravel, very moist to wet, SOFT	SPT S-4	81	4-5-50/4"		
7.5		New Albany black SHALE					

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80

>>

Refusal at 7.8 feet.
Bottom of borehole at 7.8 feet.

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CETCO
624 Wellington Way
Lexington, KY 40503
Telephone: 859-475-3933

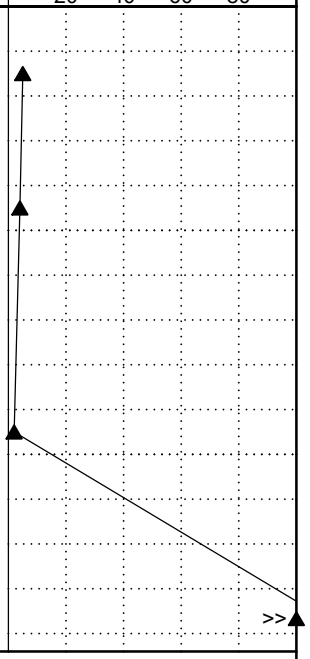
BORING NUMBER B-2

CLIENT Powells Valley Water District
PROJECT NAME Powells Valley Office Building
PROJECT NUMBER 1776-23-0123
PROJECT LOCATION Clay City, Kentucky
DATE STARTED 9/1/23 **COMPLETED** 9/1/23
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR Strata Group
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING --- Water table at 6.5 feet
LOGGED BY Hunter Hawkins **CHECKED BY** Joe Cooke, PE
AT END OF DRILLING ---
NOTES Mostly Sunny, 70's
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0.0		TOPSOIL (5")					
		Brownish gray sandy LEAN CLAY (CL), moist, FIRM	SPT S-1	89	1-2-3 (5)		
		Black interbedded SHALE layer					
		Brownish gray and orange sandy ALLUVIUM (SC), moist, SOFT	SPT S-2	100	3-2-2 (4)		
2.5		Water table at 6.5 feet					
			SPT S-3	89	1-1-1 (2)		
5.0		Brown sandy ALLUVIUM (SC), with few gravel, very moist to wet, SOFT	SPT S-4	100	8-50/2"		
		New Albany black SHALE					

Refusal at 7.2 feet.
Bottom of borehole at 7.2 feet.

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80



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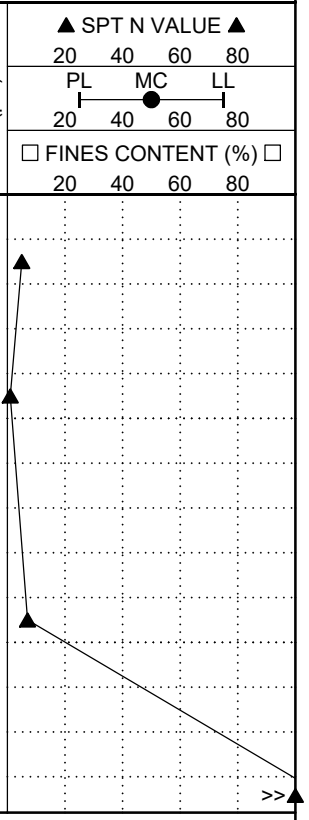
CETCO
624 Wellington Way
Lexington, KY 40503
Telephone: 859-475-3933

BORING NUMBER B-3

CLIENT Powells Valley Water District
PROJECT NAME Powells Valley Office Building
PROJECT NUMBER 1776-23-0123
PROJECT LOCATION Clay City, Kentucky
DATE STARTED 9/1/23 **COMPLETED** 9/1/23
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR Strata Group
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING --- Water table at 4.5 feet
LOGGED BY Hunter Hawkins **CHECKED BY** Joe Cooke, PE
AT END OF DRILLING ---
NOTES Mostly Sunny, 70's
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0.0		TOPSOIL (5")					
		Brownish gray sandy LEAN CLAY (CL), with few fine organics, moist, FIRM	SPT S-1	100	1-2-3 (5)		
		Brownish gray and orange sandy ALLUVIUM (SC), moist, SOFT					
2.5		Water table at 4.5 feet	SPT S-2	0	1-0-1 (1)		
		Browish orange sandy ALLUVIUM (SC), with some interbedded shale, very moist to wet, SOFT	SPT S-3	100	1-3-4 (7)		
5.0							
		New Albany black SHALE	SPT S-4	80	50/5"		

Refusal at 6.9 feet.
Bottom of borehole at 6.9 feet.



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CETCO
624 Wellington Way
Lexington, KY 40503
Telephone: 859-475-3933

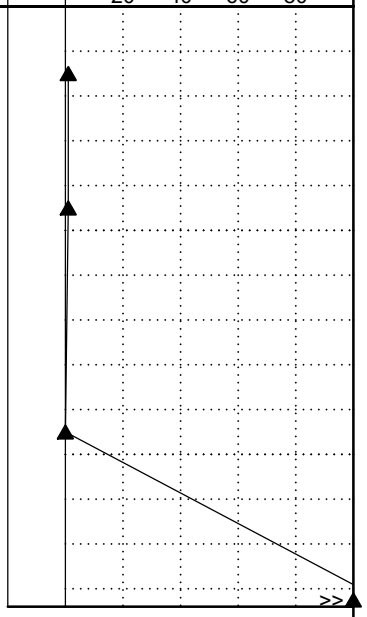
BORING NUMBER B-4

CLIENT Powells Valley Water District
PROJECT NAME Powells Valley Office Building
PROJECT NUMBER 1776-23-0123
PROJECT LOCATION Clay City, Kentucky
DATE STARTED 9/1/23 **COMPLETED** 9/1/23
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR Strata Group
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING --- Water table at 5.5 feet
LOGGED BY Hunter Hawkins **CHECKED BY** Joe Cooke, PE
AT END OF DRILLING ---
NOTES Mostly Sunny, 70's
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0.0		TOPSOIL (4")					
		Brownish gray sandy LEAN CLAY (CL), with few fine organics, moist, SOFT	SPT S-1	100	2-1-0 (1)		
		Brownish gray and orange sandy ALLUVIUM (SC), very moist, SOFT	SPT S-2	83	0-1-0 (1)		
2.5		Water table at 5.5 feet					
			SPT S-3	100	1-0-0 (0)		
5.0		Browish orange sandy ALLUVIUM (SC), very moist to wet, SOFT					
		New Albany black SHALE	SPT S-4	67	50/3"		

Refusal at 6.7 feet.
Bottom of borehole at 6.7 feet.

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80



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CETCO
624 Wellington Way
Lexington, KY 40503
Telephone: 859-475-3933

BORING NUMBER B-5

CLIENT Powells Valley Water District
PROJECT NAME Powells Valley Office Building
PROJECT NUMBER 1776-23-0123
PROJECT LOCATION Clay City, Kentucky
DATE STARTED 9/1/23 **COMPLETED** 9/1/23
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR Strata Group
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING --- Water table at 5 feet
LOGGED BY Hunter Hawkins **CHECKED BY** Joe Cooke, PE
AT END OF DRILLING ---
NOTES Mostly Sunny, 70's
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0.0		TOPSOIL (6")					
		Dark brown LEAN CLAY (CL), with some organics, moist, SOFT	SPT S-1	72	2-1-2 (3)		
		Gray sandy ALLUVIUM (SC), with few orange striations, very moist, SOFT	SPT S-2	100	0-1-0 (1)		
2.5		Water table at 5 feet					
		Grayish orange sandy ALLUVIUM (SC), very moist to wet, SOFT	SPT S-3	89	1-0-2 (2)		
5.0		New Albany black SHALE	SPT S-4	100	10-50/4"		

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80

>>

Refusal at 7.3 feet.
Bottom of borehole at 7.3 feet.

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Cooke Engineering and Testing Company

Laboratory Testing Summary Table

Project Name:	Powells Valley Water District Office	Date:	September 14, 2023
Project Location:	Clay City, KY	Reviewed by:	Joe Cooke, PE
Client:	Powells Valley Water District	CETCO Project Number:	1776-23-0114

Sample ID	Depth (ft)	Natural Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	% Finer than #200 Sieve	Maximum Dry Density (pcf)	Optimum Moisture Content (%)
B-1	0.0-1.5	18.0	NP	NP	NP	49.6		
B-1	1.5-3.0	18.1						
B-1	4.0-5.5	22.1	NP	NP	NP	57.3		
B-1	6.5-8.0	15.7						
B-2	0.0-1.5	22.6						
B-2	1.5-3.0	16.5						
B-2	4.0-5.5	24.6						
B-2	6.5-7.2	20.5						
B-3	0.0-1.5	17.4						
B-3	1.5-3.0	19.4						
B-3	6.5-6.9	14.7						
B-4	0.0-1.5	18.7						
B-4	1.5-3.0	22.1						
B-5	0.0-1.5	15.4						
B-5	1.5-3.0	22.7						

NP = Not Plastic

LABORATORY STANDARDS AND PROCEDURES

Soil Classification: Soil classifications provide a general guide to the engineering properties of various soil types and enable the engineer to apply past experience to current problems. In our investigations, samples obtained during drilling operations are examined in our laboratory and visually classified by an engineer. The soils are classified according to consistency (based on number of blows from standard penetration tests or “by hand” stiffness), color and texture. These classification descriptions are included on our "Boring Logs” or “Test Pit Logs”

The classification system discussed above is primarily qualitative and for detailed soil classification two laboratory tests are necessary: grain size tests and plasticity tests. Using these test results the soil can be classified according to the AASHTO or Unified Classification Systems (ASTM D2487). Each of these classification systems and the in-place physical soil properties provides an index for estimating the soil's behavior. The soil classification and physical properties obtained are presented in this report.

Atterberg Limits: Portions of the samples are taken for Atterberg Limits testing to determine the plasticity characteristics of the soil. The plasticity index (PI) is the range of moisture content over which the soil deforms as a plastic material. It is bracketed by the liquid limit (LL) and the plastic limit (PL). The liquid limit is the moisture content at which the soil becomes sufficiently "wet" to flow as a heavy viscous fluid. The plastic limit is the lowest moisture content at which the soil is sufficiently plastic to be manually rolled into tiny threads. The liquid limit and plastic limit are determined in accordance with ASTM D4318.

Moisture Content: The Moisture Content is determined according to ASTM D2216.

Percent Finer Than 200 Sieve: Selected samples of soils are washed through a number 200 sieve to determine the percentage of material less than 0.074 mm in diameter.

“Proctor” (Moisture-Density Test): Often called by it’s original author’s name, the “Proctor” test is a moisture-density relationship test to determine “maximum dry density” and “optimum moisture content” curves using a set amount of force of “compaction” at variable moisture contents in a pre-determined mold size. The test is typically ASTM D698, method A, for standard effort. For a “modified” effort (higher amount of force), ASTM D 1557, again method A, is usually used. Due to high amounts of clay as well as typical compaction construction equipment used, the standard Proctor (ASTM D698) is the most common method used. For materials with larger grain sizes, methods B, C and D of each ASTM method can be used.

CBR: California Bearing Ratio (CBR) testing is often performed on soils to assist in pavement design. The test involves compacting soil into an approximate “0.075 cubic foot” volume at specified density and moisture content and then soaking the compacted sample with a surcharge weight (for a time period of usually at least 96 hours). Then, the sample is “loaded” using a fixed strain penetration piston and the penetration resistance and stress is recorded (as stress in pounds per square inch-psi) at 0.1 inches and 0.2 inches penetration. The resistant stress is then compared (as a “ratio”) to the standard resistant stress, hence the value is reported as unit-less. The test is typically conducted in general accordance with ASTM D1883.

Rock Strength Tests: To obtain strength data for rock materials encountered, unconfined compression tests are performed on selected samples. In the unconfined compression test, a cylindrical portion of the rock core is subjected to increasing axial load until it fails. The pressure required to produce failure is recorded, corrected for the length to diameter ratio of the core and reported.

FIELD SERVICES STANDARDS AND PROCEDURES

Field Operations: The general field procedures employed by CETCO are summarized in ASTM D420 which is entitled "Investigating and Sampling Soils and Rocks for Engineering Purposes." This recommended practice lists recognized methods for determining soil and rock distribution and ground water conditions. These methods include geophysical, in situ methods and test pits as well as borings.

Borings are drilled to obtain subsurface samples using one of several alternate techniques depending upon the subsurface conditions. These techniques typically include:

a. Continuous 2-1/2 or 3-1/4 inch I.D. hollow stem augers;
b. Wash borings using roller cone or drag bits (mud or water);
c. Continuous flight augers (ASTM D 1425).

These drilling methods are not capable of penetrating through material designated as "refusal materials." Refusal, thus indicated, may result from hard cemented soil, soft weathered rock, coarse gravel or boulders, thin rock seams, or the upper surface of sound continuous rock. Core drilling procedures are required to determine the character and continuity of refusal materials.

The subsurface conditions encountered during drilling are reported on a field test boring record by our field personnel (typically engineers). The record contains information concerning the boring method, samples attempted and recovered, indications of the presence of various materials such as coarse gravel, cobbles, etc., and observations between samples. Therefore, these boring records contain both factual and interpretive information. The field boring records are on file in our office.

The soil and rock samples plus the field boring records are reviewed by a geotechnical engineer. The engineer classifies the soils in general accordance with the procedures outlined in ASTM D2488 and prepares the final boring records which are the basis for all evaluations and recommendations.

The final boring records represent our interpretation of the contents of the field records based on the results of the engineering examinations and tests of the field samples. These records depict subsurface conditions at the specific locations and at the particular time when drilled. Soil conditions at other locations may differ from conditions occurring at these boring locations. Also, the passage of time may result in a change in the subsurface soil and ground water conditions at these boring locations. The lines designating the interface between soil or refusal materials on the records and on profiles represent approximate boundaries. The transition between materials may be gradual. The final boring records are included with this report.

The detailed data collection methods using during this study are discussed on the following pages.

Soil Test Borings: Soil test borings were made at the site at locations shown on the attached Boring Plan. Soil sampling and penetration testing were performed in accordance with ASTM D1586.

The borings were made by mechanically twisting a hollow stem steel auger into the soil. At regular intervals, the drilling tools were removed and soil samples obtained with a standard 1.4 inch I.D., 2 inch O.D., split tube sampler. The sampler was first seated 6 inches to penetrate any loose cuttings, then driven an additional foot with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final foot was recorded and is designated the "penetration resistance". The penetration resistance, when properly evaluated, is an index to the soil strength and foundation supporting capability.

Representative portions of the soil samples, thus obtained, were placed in glass jars and transported to the laboratory. In the laboratory, the samples were examined to verify the driller's field classifications. Test Boring Records are attached which graphically show the soil descriptions and penetration resistances.

Core Drilling: Refusal materials are materials that cannot be penetrated with the soil drilling methods employed. Refusal, thus indicated, may result from hard cemented soil, soft weathered rock, coarse gravel or boulders, thin rock seams or the upper surface of sound continuous rock. Core drilling procedures are required to determine the character and continuity of refusal materials.

Prior to coring, casing is set in the drilled hole through the overburden soils, if necessary, to keep the hole from caving. Refusal materials are then cored according to ASTM D2113 using a diamond-studded bit fastened to the end of a hollow

double tube core barrel. This device is rotated at high speeds, and the cuttings are brought to the surface by circulating water. Core samples of the material penetrated are protected and retained in the swivel-mounted inner tube. Upon completion of each drill run, the core barrel is brought to the surface, the core recovered is measured, the samples are removed and the core is placed in boxes for storage.

The core samples are returned to our laboratory where the refusal material is identified and the percent core recovery and rock quality designation is determined by a soils engineer or geologist. the percent core recovery is the ratio of the sample length obtained to the depth drilled, expressed as a percent. The rock quality designation (RQD) is obtained by summing up the length of core recovered, including only the pieces of core which are four inches or longer, and dividing by the total length drilled. The percent core recovery and RQD are related to soundness and continuity of the refusal material. Refusal material descriptions, recoveries, and RQDs are shown on the "Test Boring Records".

Water Level Readings: Water table readings are normally taken in conjunction with borings and are recorded on the "Boring Logs". These readings indicate the approximate location of the hydrostatic water table at the time of our field investigation. Where impervious soils are encountered (clayey soils) the amount of water seepage into the boring is small, and it is generally not possible to establish the location of the hydrostatic water table through water level readings. The ground water table may also be dependent upon the amount of precipitation at the site during a particular period of time. Fluctuations in the water table should be expected with variations in precipitation, surface run-off, evaporation and other factors.

The time of boring water level reported on the boring records is determined by field crews as the drilling tools are advanced. The time of boring water level is detected by changes in the drilling rate, soil samples obtained, etc. Additional water table readings are generally obtained at least 24 hours after the borings are completed. The time lag of at least 24 hours is used to permit stabilization of the ground water table which has been disrupted by the drilling operations. The readings are taken by dropping a weighted line down the boring or using an electrical probe to detect the water level surface.

Occasionally the borings will cave-in, preventing water level readings from being obtained or trapping drilling water above the caved-in zone. The cave-in depth is also measured and recorded on the boring records.

Rock Classification: Rock classifications (if any) provide a general guide to the engineering properties of various rock types and enable the engineer to apply past experience to current situations. In our explorations, rock core samples obtained during drilling operations are examined in our laboratory and visually classified by an engineer. The rock cores are classified according to relative hardness and RQD (see Guide to Rock Classification Terminology), color, and texture. These classification descriptions are included on our Boring Records.

Test Pits: Occasionally, our field sampling includes the use of “test pits”. Similarly to soil test borings, our classifications on the materials observed and sampled are performed in general accordance with ASTM standards. These excavations are performed by excavators of various sizes and the width/length/depth of the excavations vary as well. Typically, only the soil or “loose” rock areas can be sampled or excavated. The samples taken are usually taken at highly variable depths and the engineer or field personnel have extreme discretion on the sample sizes and locations. These are typically sealed in “zip lock” type baggies and transported back to our office for lab testing and further classification. Visual descriptions of rock materials (sand, gravel, cobbles, boulders, etc.) are provided on both samples taken and observations of spoils removed and sides of excavations. Typically, photos of both the mass excavation and spoil pile are provide on the test pit logs in our reports. Groundwater levels are noted and can include water flow at the excavation bottom or at points of depth in the excavation sides. “Refusal” usually means that the excavator cannot remove additional materials at the excavation bottom. Some excavations may also have very large boulders than cannot be removed by the excavator used. Depths indicated on the logs are usually measured with steel tape or cloth tape. Final complete details of the test pit findings and opinions are provided in the “Test Pit Logs” in our reports. Lastly, test pit excavations have no set standards and are performed at our engineers discretion.

Field and Lab Procedures