September 24, 2024

GEOTECHNICAL REPORT

# ROWAN CO. SENIOR CENTER

# MOREHEAD, KY


CETCO

***Cooke Engineering and Testing Company***

September 24, 2024

Mr. Marty Friedman
MSE of Kentucky, Inc
via email: mfriedman@mselex.com

Subject: **Geotechnical Report**
Rowan Co. Senior Center
Morehead, Kentucky
CETCO Project No. 1776-24-0138

Dear Mr. Friedman:

**CETCO** appreciates the opportunity to provide our services to you and the Owner (Rowan County Fiscal Court). As follows, we are providing our geotechnical report. Our services were provided in general accordance with our proposal number CET 1776-24-0300, dated, August 2, 2024. 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**

Hunter Hawkins, SI
Staff Geologist

STATE OF KENTUCKY
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21244
LICENSED PROFESSIONAL ENGINEER

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Cooke Engineering and Testing Company

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# Rowan Co. Senior Center

## MOREHEAD, KENTUCKY

## GEOTECHNICAL REPORT SUMMARY

We provided our services in general accordance with our previous discussions and our proposal number 1776-23-0300, dated - August 2, 2024 and approved by the Owner. We discussed the need for CETCO to provide geotechnical services including sampling and exploration with soil test borings, 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 senior citizens center building project. The project plans are in the design stage, but may change. CETCO should be advised on any changes from the information presented in our report. The site is located off of Clearfield Street in Morehead, Kentucky. Potential concept plans indicate a 5,800 square foot, single story building as the new Rowan County Senior Citizens Center. 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, “thin” mostly brown “silty” lean clay found in Morehead. Groundwater was encountered in one of our borings at 11 feet. Sandstone and siltstone bedrock was encountered in all borings ranging from about 6 to 12 feet deep at the site. The native clay soils were typically stiff.

The site is suitable for the development. Once the pad is leveled and filled properly, we believe ***shallow spread footings can be used*** for the proposed single story building. ***Conventional slab-on-grade floors are also suitable*** for the proposed building.

The primary concerns for the site are the “normal” Morehead, Kentucky risks of: silty/sandy clays and potential shallow water. Also, the site location is in a previously disturbed area: remnants of former improvements or disturbed soils should be expected. However, ***normal construction and planning practices of the Morehead area are expected.*** Details for these issues and recommendations for design and construction as well as our other recommendations are discussed in the report.

# 1 PROJECT BACKGROUND

## 1.1 CETCO SCOPE OF SERVICES

Our scope of services included conducting an exploration of the subsurface conditions for the proposed new building pad site. This including using eight soil test borings, observing site and site area conditions and providing geotechnical analysis. We have completed our field work, analysis and we are issuing the geotechnical report as follows.

## 1.2 PROVIDED INFORMATION

We were provided information for the project as follows:

| Provided Document | Source |
|---|---|
| Site drawings are in the “initial” stages. The provided sketches shows the potential building and parking layouts on the site. | MSE |
| Site/property survey plat | MSE |

The following information summarizes our understanding of the project conditions

| Condition | Specifics |
|---|---|
| Building/Structure Information | The building is single story and will be about 5,800 square feet in size. Slab-on-grade floors, shallow spread footing foundations, stud framed walls and overall wood framework is expected. |
| Site Grading | The site is mostly flat to mildly sloped. Therefore, it is anticipated to have cuts/fills of 5 feet or less. |

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.

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## 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 northern section and western edge of the Eastern Kentucky Coal Field region of Kentucky. Specifically, the area is called the “Pottsville Escarpment”, with a dramatic change in topography (steep hillsides and narrow valleys) in this transition area from “mountainous” of the coal field region to “rolling hills” of the Bluegrass Region (to the west). The overall area can have resistant Pennsylvanian-age sandstones with steep and generally stable slopes, but also have soft shale or siltstone bedrock areas with “unstable” slopes. This region is dissected by headstreams of the Licking, Kentucky and Cumberland Rivers and often contain, springs, entrenched rivers, and sinking streams. The site location consists of Lower Mississippian age rocks that tend to be shallow depth to layered bedrock. Elevations in the area range from just under 700 feet along creek valley bottoms to over 1400 feet along mountaintops. The immediate site vicinity elevations range from about 710 to 730 feet according provided topography, our site GPS measurements and published mapping.

### SITE GEOLOGY

The Kentucky Geologic Survey public information was reviewed including the USGS mapped geologic information for the site (the Morehead Geological Quadrangle, 1972). Available geologic mapping indicates the site vicinity is underlain by the Alluvium from Triplett Creek east of the site location. Alluvium is made up of tannish brown clay, sand and gravel. The Borden Formation underlies the Alluvium. Specifically, the site is likely underlain by the lower portions of the Borden, which includes the Nancy and Farmers Members. These units contain layers of shale, siltstone and sandstone. The Nancy unit also is noted as containing common lenses of “ironstone”, which is very, very hard and noted as being extremely difficult to excavate. Bedrock is generally in shades of brown, but bluish gray is also common.

Images of the mapped site geology are shown on the next page.

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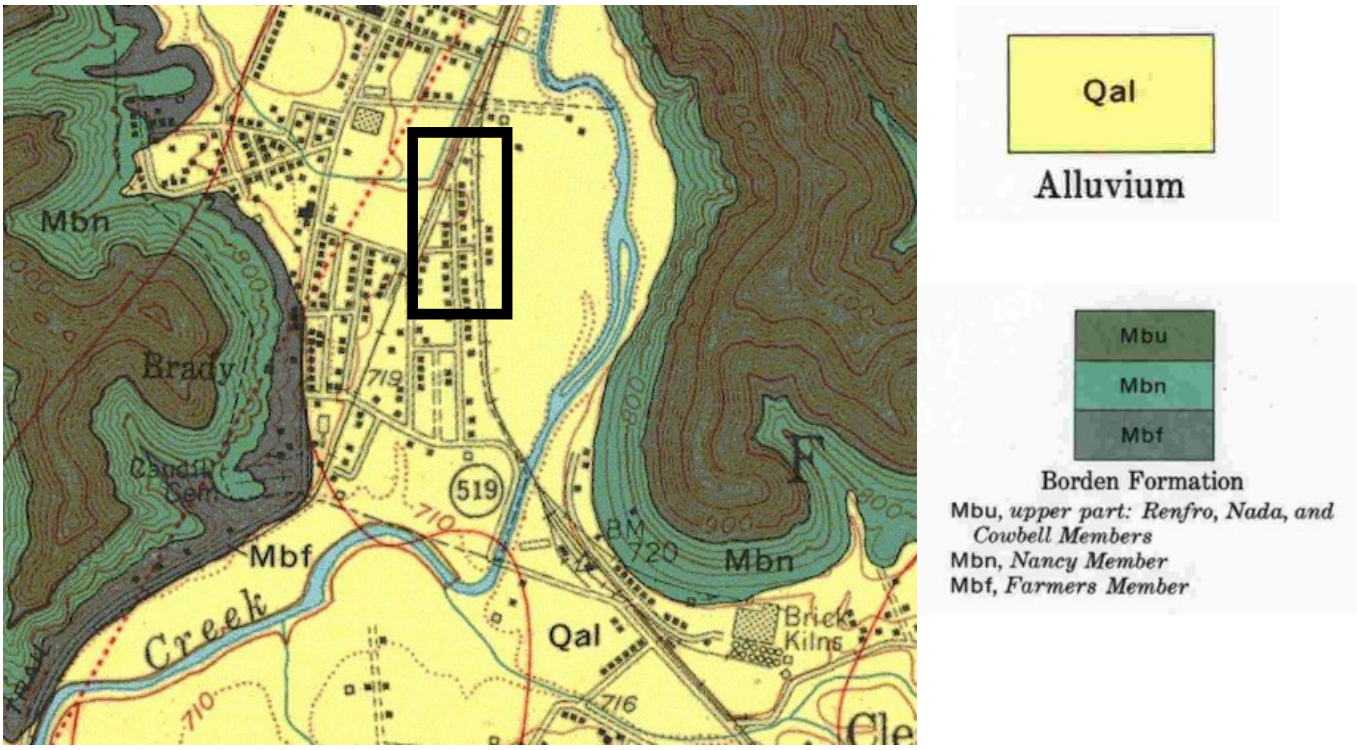



Image from the KGS website showing current aerial overlaying Original Geological Quadrangle Site location is the black rectangle.

## AERIAL MAPPING AND SITE HISTORY

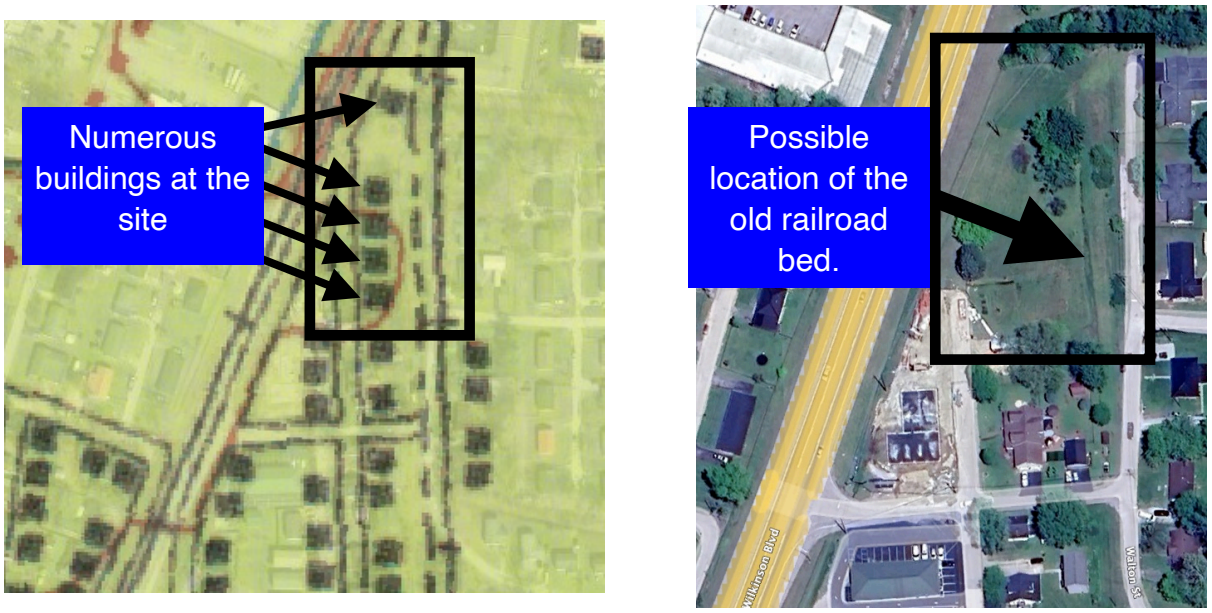
Aerial information back as far as 1995 was readily available for the site. Images showing site progression. Photo on the left is the aerial from 1995, showing residential area south of the site. The site vicinity had minimal changes until sometime between 2019 and 2023 where the Rowan County EMS Station 2 Building was recently constructed southwest of the site location. The 2023 aerial shows the current condition of the site location.

1995 : Aerial from Google Earth

2019 : Aerial from Google Earth

2023 : Aerial from Google Earth

Other published site mapping, including the aforementioned geologic mapping (1972), show that the site and immediate area have been used as residential areas. This includes several houses/buildings mapped on the geologic mapping at the site. Also, a railroad was located just east of the site, likely along the layout of immediate west side of Walton Street (the east edge of the site). See the imagery below for the mapping of these areas.




Imagery: left, USGS 1972 mapping showing several buildings at the site and railroad on the eastern edge and right, 2023 aerial showing the site conditions with a noticeable outline of the possible railroad location. Site is shown in the rectangle in both images.

## SITE SOIL SURVEY MAPPING AND WATER WELL MAPPING

The Soil Survey of the site area was also reviewed. Issues affecting the site development included: depth to saturated zone and depth to thin cemented pan. Also, nearby water wells indicate water as shallow as 6 to 8 feet deep. We are providing recommendations to address these issues.

Also, the soil survey lists the site as having “high risk” for corrosion of steel and concrete. 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 3 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, SI, staff geologist, provided our field services including a site reconnaissance and logging of the borings in the field, during the exploration on August 14, 2024. Mr. Joe Cooke, PE, also observed site conditions and observed recovered soil samples.

## 2.1 CURRENT SITE SURFACE CONDITIONS AND OBSERVATIONS

The site is located off of Clearfield Street in Morehead, Kentucky. There are commercial and municipal businesses southwest of the site, including the new Rowan County EMS Station 2. A residential neighborhood is south and east of the site. The western border is marked by a fence line with W Wilkinson Blvd beyond. The eastern boundary is a ditch line with Walton Street just east. The northern boundary is a fence line with a fork of Triplett Creek beyond running east to west. Clearfield Street dead ends into the site location, where multiple utility lines run north to northeast throughout the site. The site is mostly an open, ankle high grassy field with few trees and brush piles on the north and western portions of the site. The west and northern boundaries are fenced off, and the southern and eastern boundaries are open. There is a previous railroad (see historic mapping) that ran north to south along the eastern boundary of the site, where the property owner believes that the railroad ties are still in the ground. The old rail bed is noticeable based on site grading (see photos). Currently, the area is covered with grass and appears to be a drainage ditch. The overall site is mostly level, but slopes slightly downward to the east and north.

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.

The following page shows photos of the area at the time of our field work.

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# Project Photos

| Description | Photo |
|---|---|
| Overview showing grassy field with few trees. Facing north. |  |
| Photo example taken of the northern portion of the site, showing a fence line in the background with few brush piles scattered. Facing north. |  |

# Project Site Photos (cont.)-1

| Description | Photo |
|---|---|
| Photo example of the western side with Clearfield Street in the background. Facing west. |  |
| Photo example showing the house at the southern portion of the property. Facing southwest. |  |

# Project Site Photos (cont.)

| Description | Photo |
|---|---|
| Photo example of the northwestern portion of the site, where multiple utility lines run north from Clearfield Street. Facing north. |  |
| Photo example of the eastern boundary of the property, showing a ditch line and "hump" on the east edge, that was likely previously a railroad. Facing north. |  |

## 2.2 SUBSURFACE INFORMATION SUMMARY

A total of 8 soil boring tests were utilized to explore the subsurface conditions at the site. The borings were drilled in locations to provide an indication of the overall site subsurface conditions. The boring location plan in the appendix shows the approximate drilling locations.

SUBSURFACE CONDITIONS: At our sampling locations, we encountered a thin layer of "clean" previously placed fill (5 out of 8 borings) overlying native soils (aka: old fill). The native soils were generally "silty clay" and were brown to orange/gray in coloring with some sand and gravel (likely alluvium), overlying weathered siltstone and sandstone bedrock. 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 | 4-8 inches | All borings showed topsoil |
| Previously Placed Fill (old fill): Appeared to be "clean fill" generally sampled as dark brown/gray lean clay with some gravel and organics. | 1-4 feet | 5 out of 8 borings showed this strata |
| Upper Native Soils: mostly "silty" clay, light brown to brown, with gray, in coloring and generally "moist" and "stiff". | 2-4 feet | All borings except B-5 showed this strata |
| Lower Native Soils: mostly "silty" clay, with some fine sand and gravel. Generally gray, orange and brown in coloring and generally "moist" and "stiff". | 2-5 feet | All borings except B-6 showed this strata |
| Bedrock: Soft to hard siltstone or sandstone. | N/A | All borings encountered bedrock |

Auger refusal was encountered in all 8 borings. Auger refusal is interpreted at the top of siltstone or sandstone bedrock. The table below shows depth to Auger Refusal.

| Boring Number | Auger Refusal Depth (ft) | Boring Number | Auger Refusal Depth (ft) |
|---|---|---|---|
| B-1 | 9.9 | B-5 | 6.6 |
| B-2 | 9.5 | B-6 | 6.2 |
| B-3 | 8.1 | B-7 | 8.6 |
| B-4 | 12.9 | B-8 | 9.5 |

GROUNDWATER CONDITIONS: Free water or "wet" conditions were encountered in one boring (B-4) at approximately 11 feet deep. The remaining borings did not encounter free water.

# 3 OPINIONS AND DISCUSSION

SUMMARY: In general, the project site is suitable for the proposed new building 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.

- Silty and Sandy Soils
- Possible Wet Conditions
- Previous Construction in an Urban Area (including old fill)

**Silty and Sandy Soils**

The site and site areas soils are notoriously “silty” and can have “sandy” pockets. These soils can the appearance of pumping and rutting, despite being stable. **Silty soils become easily destabilized during wet weather or when exposed to heavy, repetitive construction traffic. Site grading during “dry” weather is warranted. Wet conditions will require stabilization methods such as undercutting and replacement or the use of larger amounts of stabilizing gravel. Construction entrances (areas exposed to large amounts of repetitive traffic) may require thicker than normal gravel.** Sandy soils will slump/slough in open excavations and the use of a trench box is warranted for site utility construction. These issues suggest that an earthwork contractor and geotechnical engineer with experience in Rowan County is warranted to avoid unnecessary undercutting and earthwork costs.

**Possible Wet Conditions and Some Soft Soil Areas**

One boring encountered wet conditions at approximately 11 feet deep. This boring was on the northern section of the site closest to the stream just beyond the northern border. The remaining borings were dry upon completion of drilling and only a few zones in our borings might be considered very moist. **However, our experience in the area and the soil mapping**

**indicate shallow wet conditions are common to the area.** This includes pockets within the soil mass, horizontal areas of widespread wet conditions in the soil and some wet weather springs. **It is our recommendations that at least 25% additional consideration (budgets and time) for dewatering and undercut allowances be placed in project planning/ estimates.**

**Previous Construction in an Urban Area (including old fill)**

Five out of eight of our borings encountered previously placed fill (old fill), as thick as 4 feet deep, at the site (most likely 2 to 3 feet deep on average). The fill is likely derived from previous site or site adjacent construction/development. Much of this occurred several decades ago. The fill appears to be clean fill, therefore the fill can likely be “re-usable” material. **The building pad could likely bear on this material (if it passes a proof roll), but foundations should not bear on the material, which may require one to two feet of undercutting in foundation trenches (down to firm or better native soils). These can simply be backfilled up to bottom of footing elevations with compacted gravel (DGA or #2 stone).**

Several former “houses” and a former railroad line were located at the site. The house remnants may have been removed, but some items may remain. If encountered within the new building limits, these materials should be removed and the excavation backfilled according to our earthwork recommendations. **The former railroad ballast and/or cross ties are reportedly in-place (eastern edge of the site). Excavations on this section should be aware of this possibility. Building features should not bear on existing railroad materials.**

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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. **The site soils are very silty: 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. Stabilization methods such as large amounts of undercutting and replacement or the use of larger amounts of stabilizing gravel should be expected, especially during wet periods of the year**. 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;
- 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;
- As stated, the on-site pavement areas and new slab can likely be supported by the upper “old fill” layer if the layer passes a proof roll;
- **The silty soils on site often do not “pass” a proof roll, even when at or near optimum moisture conditions. CETCO should be on-site to observe and evaluate soil stability;**
- 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. The backfill should be consistent with the requirements listed in section 4.2;
- **Wet zones could be encountered, especially near the northern section of the property. CETCO should be contacted to provide guidance on undercutting and other means of addressing wet zones;**

- CETCO should observe the proofrolling operations and make recommendations for any unstable or unsuitable conditions encountered.

## 4.2 EARTHWORK

The site is somewhat "level/flat" across the site, with less than 5 feet of cut/fill expected. We are providing the following recommendations 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 25.
    - **The soil on site is silty. Construction traffic beyond the required amount to enable adequate compaction and stability should be avoided.**
- 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 **Do not over compact the soils. Moisture content should be from minus 3 to plus 1 percent of optimum moisture content (range is such due to the silty nature of the on-site materials)**;
    - Soil should never be placed "dry" (dusty). CETCO should observe fill placement to determine acceptable soil moisture;
- 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;
- 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. Should heavy seepage occur, or should there be evidence of soil particle migration such as silting of the sump, then the geotechnical engineer should be contacted.

**As mentioned previously, at least 25% additional dewatering time and budget should be considered due to the common “shallow water” conditions in the area.**

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;
- Diversion ditches should be used at the toe of all slopes to keep surface water from accumulating at or near site structures;
- For excavations during construction, most free water from the subsurface conditions could likely be removed via sump pumps and open channel flow (ditches) at or near the source of seepage. However, if normal dewatering measures prove insufficient, CETCO should be retained to provide recommendations on the issue;

## 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 "C" 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.

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## 4.4 FOUNDATIONS

The following recommendations are also based on the previously described project information, typical single story 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 3,000 pounds per square foot (psf) is recommended for footings bearing on firm or better native soils or compacted engineered fill.***

- **Again, foundations should not bear on the old fill materials.**

    - Borings indicate that the old fill as deep as 4 feet. Footings should bear on firm or better native soils and must penetrate the old fill.
    - Once firm or better native soils have been encountered, the footing trenches can be backfill with compacted gravel (DGA or #2 stone) up to bottom of footing depth and normal footing concrete and rebar then be placed.

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 below finished exterior grade for frost protection depth;

**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 conditions should be assessed by means of dynamic cone penetration (DCP) testing and hand auger borings at all footing locations.

- 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.
- 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 the site soils, **provided they pass a proof roll test and are deemed stable by CETCO.** 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:

- 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.

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## 4.6 PAVEMENT RECOMMENDATIONS

We have assumed mostly light duty (passenger car traffic) areas of parking as well as medium duty (passenger cars and delivery trucks) for the site and long-term project usage. No repetitive tractor trailer or other heavy-duty traffic is expected.

The most significant areas of traffic we have assumed 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.

The subsurface conditions on-site include the surface layer of “old fill” and some areas of native silty soil cover. As sampled, the material is mostly clay soil. If the area “passes” a proof roll, the 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.

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 |
|---|---|
| Asphalt 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 NX750 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.

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# 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.

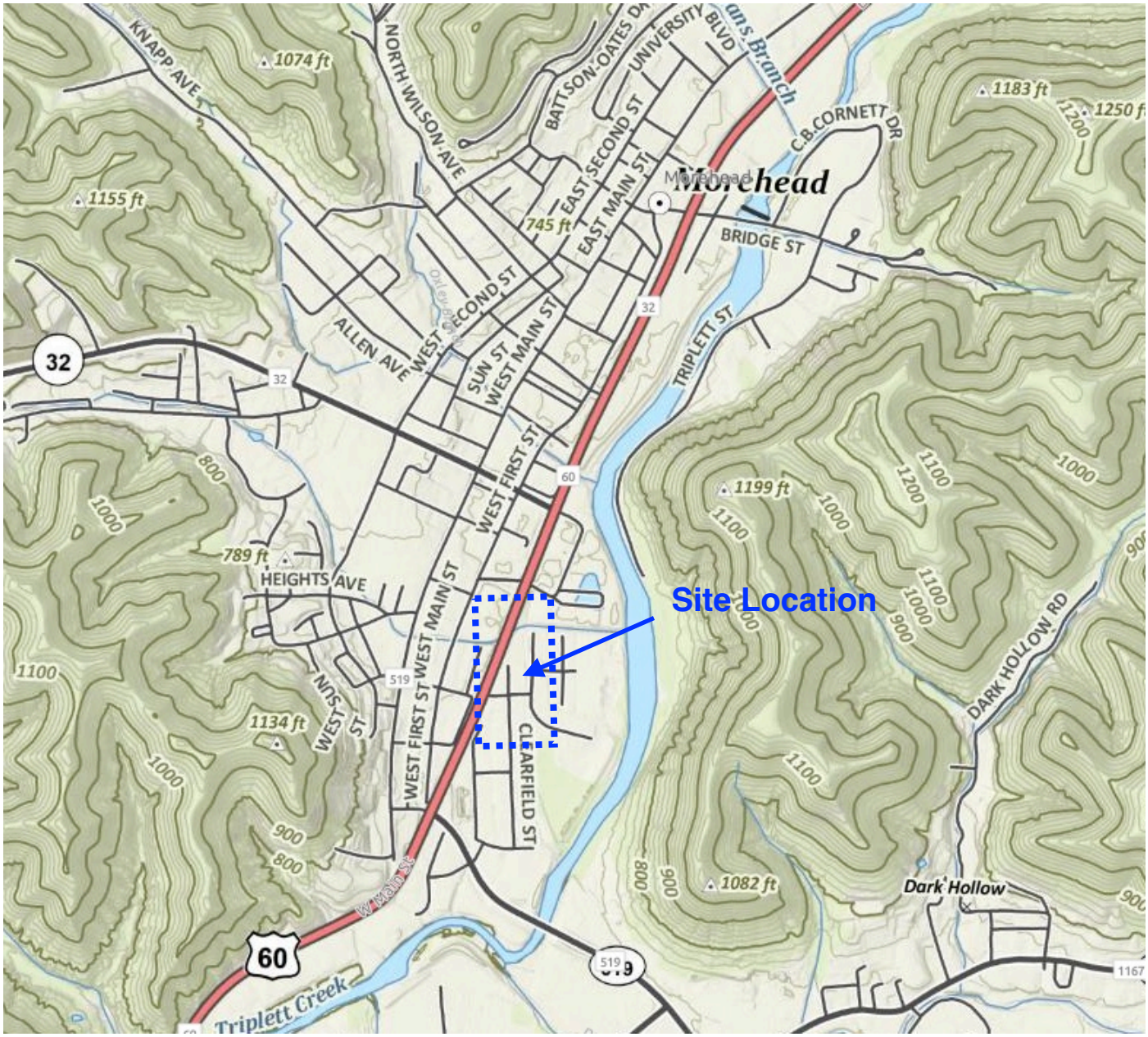
Regardless of the thoroughness of a geotechnical exploration, there is always a possibility that conditions between borings/test pits will be different from those at specific boring/test pit locations and that conditions will not be as anticipated by the designers or contractors. In addition, the construction 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.

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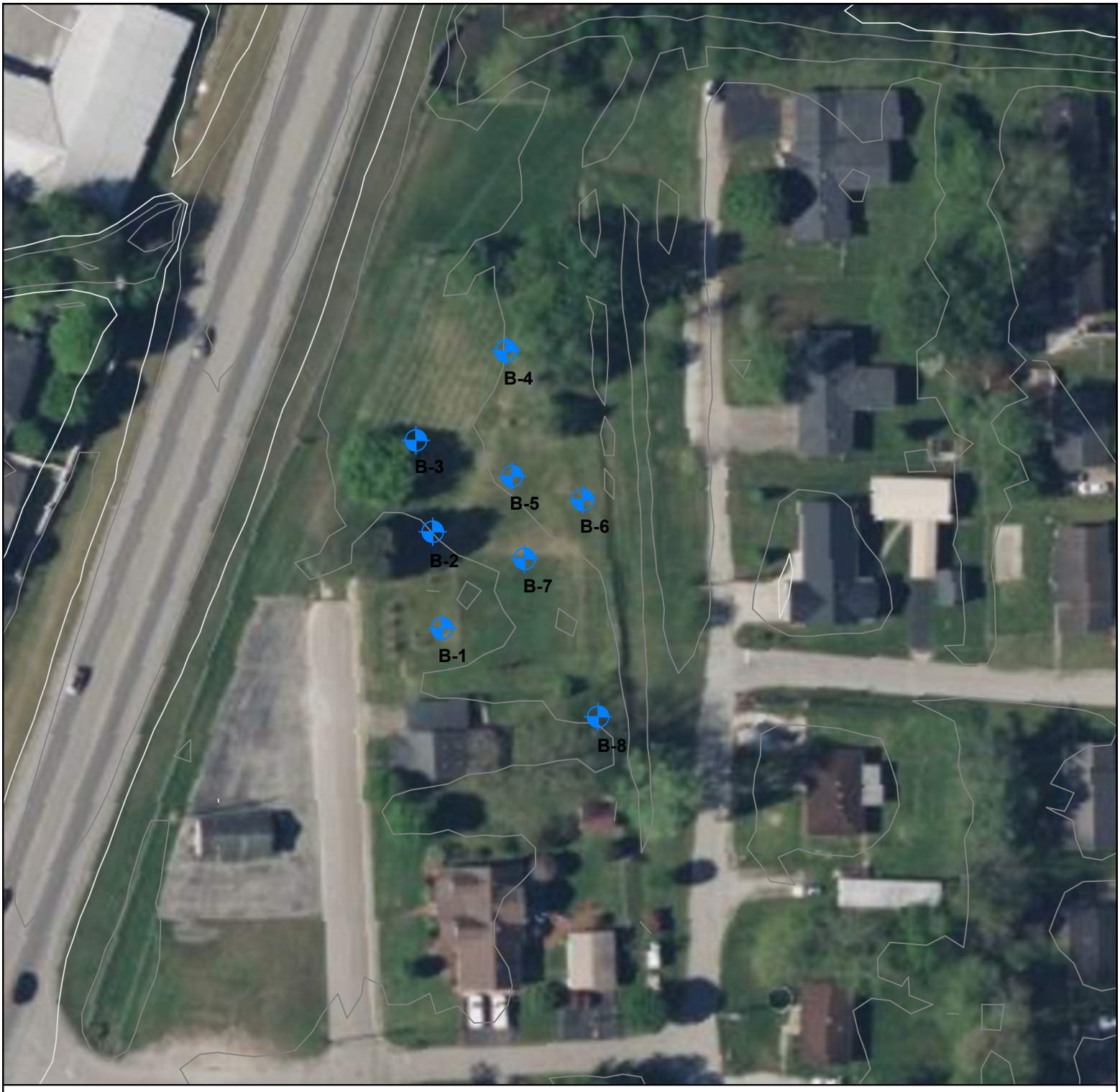
www.cetcopllc.com

**SITE LOCATION PLAN**
for Rowan Co. Senior Center

Morehead, Kentucky

CETCO Project: 1776-24-0137
Date: August 19 2024
Drawn by: Mason Ross
Checked by: Joe Cooke, PE
Drawing: 1 of 1




## Legend

- Boring B-X
- 10' Contour
- 2' Contour

Boring location plan adapted from Google Earth and GeoSync, with further adaptations from CETCO professionals. Drilling locations were collected on-site using GPS equipment.

N

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# BORING LOCATION PLAN

For Rowan Co. Senior Center

Morehead, Kentucky

| | |
|---|---|
| CETCO Project: | 1776-24-0138 |
| Date: | August 16, 2024 |
| Drawn by: | Mason Ross |
| Checked by: | Joe Cooke, PE |
| Drawing: | 1 of 1 |
| Scale: | NTS |

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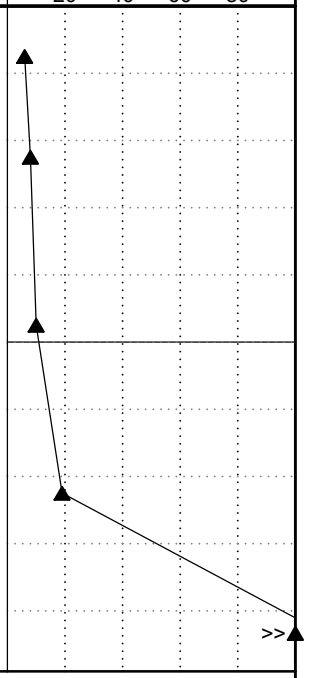
# BORING NUMBER B-1



**CLIENT** MSE
**PROJECT NAME** Rowan County Senior Citizens Center
**PROJECT NUMBER** 1776-23-0138
**PROJECT LOCATION** Morehead, Kentucky
**DATE STARTED** 8/15/24 **COMPLETED** 8/15/24
**GROUND ELEVATION** 718 ft **HOLE SIZE** 4"
**DRILLING CONTRACTOR** Strata Group
**GROUND WATER LEVELS:**
**DRILLING METHOD** Hollow Stem Auger
**AT TIME OF DRILLING** ---
**LOGGED BY** Hunter Hawkins **CHECKED BY** Joe Cooke, PE
**AT END OF DRILLING** --- Dry upon completion of drilling
**NOTES** Mostly Sunny, 80's
**AFTER DRILLING** ---

| DEPTH (ft) | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) |
|---|---|---|---|---|---|---|
| 0 | TOPSOIL (5") | | | | | |
| | Brown LEAN CLAY (CL), silty, with some fine organics and few black odixes, slightly moist, FIRM | SPT S-1 | 100 | 2-3-3 (6) | | |
| | Light brown and gray LEAN CLAY (CL), silty, slightly moist, FIRM | SPT S-2 | 100 | 5-4-4 (8) | | |
| 5 | Brownish orange and gray LEAN CLAY (CL), silty, with trace fine sand, moist, STIFF | SPT S-3 | 94 | 4-4-6 (10) | | |
| | Gray and brown LEAN CLAY (CL), silty, with some fine sand and few gravel, moist, VERY STIFF | SPT S-4 | 100 | 4-6-13 (19) | | |
| | Brownish gray and orange LEAN CLAY (CL), slightly layered, silty, with some fine sand and few gravel, moist, STIFF | SPT S-5 | 100 | 9-50/2" | | |
| | Weathered SANDSTONE | | | | | |

Refusal at 9.9 feet.
Bottom of borehole at 9.9 feet.



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# BORING NUMBER B-2

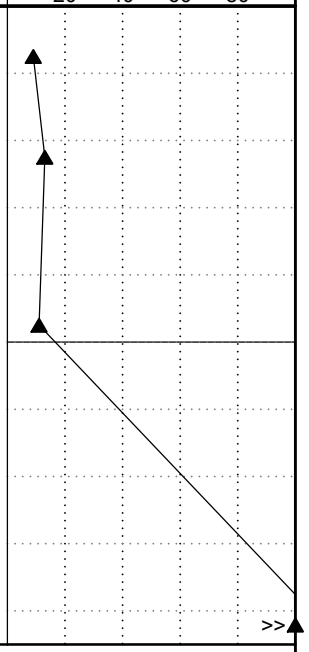


**CLIENT** MSE
**PROJECT NAME** Rowan County Senior Citizens Center
**PROJECT NUMBER** 1776-23-0138
**PROJECT LOCATION** Morehead, Kentucky
**DATE STARTED** 8/15/24 **COMPLETED** 8/15/24
**GROUND ELEVATION** 718 ft **HOLE SIZE** 4"
**DRILLING CONTRACTOR** Strata Group
**GROUND WATER LEVELS:**
**DRILLING METHOD** Hollow Stem Auger
**AT TIME OF DRILLING** ---
**LOGGED BY** Hunter Hawkins **CHECKED BY** Joe Cooke, PE
**AT END OF DRILLING** --- Dry upon completion of drilling
**NOTES** Mostly Sunny, 80's
**AFTER DRILLING** ---

| DEPTH (ft) | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) |
|---|---|---|---|---|---|---|
| 0 | TOPSOIL (6") | | | | | |
| | Light brown LEAN CLAY (CL), silty, slightly moist, STIFF | SPT S-1 | 89 | 2-3-6 (9) | | |
| | Light brown and gray LEAN CLAY (CL), silty, slightly moist, STIFF | SPT S-2 | 100 | 5-6-7 (13) | | |
| 5 | Brownish orange and gray LEAN CLAY (CL), silty, with trace fine sand, moist, STIFF | SPT S-3 | 100 | 4-5-6 (11) | | |
| | Brownish orange and gray weathered SILTSTONE, layered, HARD | SPT S-5 | 100 | 50/5" | | |
| | Weathered SANDSTONE | | | | | |

Refusal at 9.5 feet.
Bottom of borehole at 9.5 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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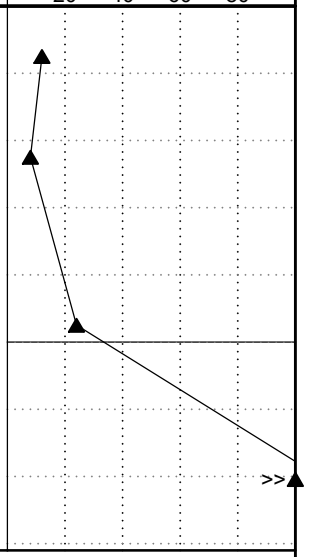
# BORING NUMBER B-3



**CLIENT** MSE
**PROJECT NAME** Rowan County Senior Citizens Center
**PROJECT NUMBER** 1776-23-0138
**PROJECT LOCATION** Morehead, Kentucky
**DATE STARTED** 8/15/24 **COMPLETED** 8/15/24
**GROUND ELEVATION** 716 ft **HOLE SIZE** 4"
**DRILLING CONTRACTOR** Strata Group
**GROUND WATER LEVELS:**
**DRILLING METHOD** Hollow Stem Auger
**AT TIME OF DRILLING** ---
**LOGGED BY** Hunter Hawkins **CHECKED BY** Joe Cooke, PE
**AT END OF DRILLING** --- Dry upon completion of drilling
**NOTES** Mostly Sunny, 80'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 | | TOPSOIL (7") | | | | | |
| | | PREVIOUSLY PLACED FILL: Dark brown LEAN CLAY (CL), with many gravel fragments and few organics, silty, moist, STIFF | SPT S-1 | 100 | 3-7-5 (12) | | |
| | | Brown and gray LEAN CLAY (CL), silty, slightly moist, FIRM | SPT S-2 | 67 | 4-4-4 (8) | | |
| 5 | | Brownish orange and gray LEAN CLAY (CL), slightly layered, silty, with trace fine sand, moist, VERY STIFF | SPT S-3 | 67 | 5-7-17 (24) | | |
| | | Brownish gray and orange LEAN CLAY (CL), slightly layered, silty, with some fine sand and few gravel, moist, VERY STIFF | SPT S-4 | 100 | 13-15-50/1" | | |
| | | Weathered SANDSTONE | | | | | |

Refusal at 8.1 feet.
Bottom of borehole at 8.1 feet.



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# BORING NUMBER B-4



**CLIENT** MSE
**PROJECT NAME** Rowan County Senior Citizens Center
**PROJECT NUMBER** 1776-23-0138
**PROJECT LOCATION** Morehead, Kentucky
**DATE STARTED** 8/15/24 **COMPLETED** 8/15/24
**GROUND ELEVATION** 717 ft **HOLE SIZE** 4"
**DRILLING CONTRACTOR** Strata Group
**GROUND WATER LEVELS:**
**DRILLING METHOD** Hollow Stem Auger
**AT TIME OF DRILLING** ---
**LOGGED BY** Hunter Hawkins **CHECKED BY** Joe Cooke, PE
**AT END OF DRILLING** 11.00 ft / Elev 706.00 ft Water level at ~ 11'
**NOTES** Mostly Sunny, 80'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 | | TOPSOIL (7") | | | | | |
| | | PREVIOUSLY PLACED FILL: Dark brown LEAN CLAY (CL), with few gravel fragments, organics, and glass fragments, silty, moist, STIFF | SPT S-1 | 83 | 2-5-6 (11) | | |
| | | | SPT S-2 | 33 | 4-3-3 (6) | | |
| 5 | | Brown and gray LEAN CLAY (CL), silty, moist, FIRM | SPT S-3 | 100 | 3-3-3 (6) | | |
| | | Brownish orange LEAN CLAY (CL), slightly layered, silty, with trace fine sand, moist to very moist, FIRM | SPT S-4 | 89 | 3-2-2 (4) | | |
| 10 | | | SPT S-5 | 67 | 2-2-3 (5) | | |
| | | Water level at approximately 11' | | | | | |
| | | Weathered SANDSTONE | | | | | |

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

Refusal at 12.9 feet.
Bottom of borehole at 12.9 feet.

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# BORING NUMBER B-5

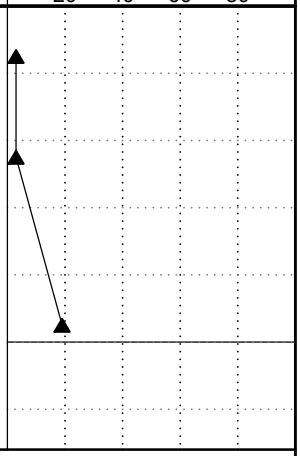


**CLIENT** MSE
**PROJECT NAME** Rowan County Senior Citizens Center
**PROJECT NUMBER** 1776-23-0138
**PROJECT LOCATION** Morehead, Kentucky
**DATE STARTED** 8/15/24 **COMPLETED** 8/15/24
**GROUND ELEVATION** 717 ft **HOLE SIZE** 4"
**DRILLING CONTRACTOR** Strata Group
**GROUND WATER LEVELS:**
**DRILLING METHOD** Hollow Stem Auger
**AT TIME OF DRILLING** ---
**LOGGED BY** Hunter Hawkins **CHECKED BY** Joe Cooke, PE
**AT END OF DRILLING** --- Dry upon completion of drilling
**NOTES** Mostly Sunny, 80'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 | | TOPSOIL (7") | | | | | |
| | | PREVIOUSLY PLACED FILL: Dark brown LEAN CLAY (CL), with many gravel fragments and few organics, silty, moist, SOFT | SPT S-1 | 83 | 1-2-1 (3) | | |
| | | | SPT S-2 | 33 | 1-1-2 (3) | | |
| 5 | | Brownish gray and orange LEAN CLAY (CL), slightly layered, silty, with some fine sand and some gravel, moist, VERY STIFF | SPT S-3 | 100 | 3-4-15 (19) | | |
| | | Weathered SANDSTONE | | | | | |

Refusal at 6.6 feet.
Bottom of borehole at 6.6 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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Lexington, KY 40503
Telephone: 859-475-3933

# BORING NUMBER B-6

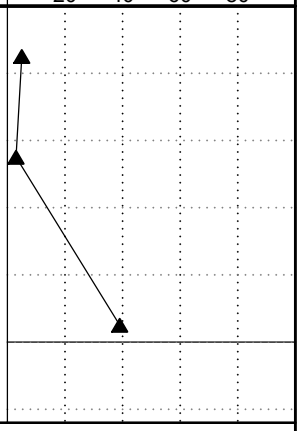


**CLIENT** MSE
**PROJECT NAME** Rowan County Senior Citizens Center
**PROJECT NUMBER** 1776-23-0138
**PROJECT LOCATION** Morehead, Kentucky
**DATE STARTED** 8/15/24 **COMPLETED** 8/15/24
**GROUND ELEVATION** 716 ft **HOLE SIZE** 4"
**DRILLING CONTRACTOR** Strata Group
**GROUND WATER LEVELS:**
**DRILLING METHOD** Hollow Stem Auger
**AT TIME OF DRILLING** ---
**LOGGED BY** Hunter Hawkins **CHECKED BY** Joe Cooke, PE
**AT END OF DRILLING** --- Dry upon completion of drilling
**NOTES** Mostly Sunny, 80'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 | | TOPSOIL (5") | | | | | |
| | | PREVIOUSLY PLACED FILL: Dark brownish gray LEAN CLAY (CL), with trace gravel fragments organics, silty, moist, FIRM | SPT S-1 | 83 | 2-3-2 (5) | | |
| | | Light brown LEAN CLAY (CL), with trace black oxides and red striations, silty, moist, SOFT | SPT S-2 | 100 | 2-1-2 (3) | | |
| 5 | | Brownish orange slightly layered SILTSTONE, with some interbedded gravel, slightly moist, HARD | SPT S-3 | 100 | 9-14-25 (39) | | |
| | | Weathered SANDSTONE | | | | | |

Refusal at 6.2 feet.
Bottom of borehole at 6.2 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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Lexington, KY 40503
Telephone: 859-475-3933

# BORING NUMBER B-7



**CLIENT** MSE
**PROJECT NAME** Rowan County Senior Citizens Center
**PROJECT NUMBER** 1776-23-0138
**PROJECT LOCATION** Morehead, Kentucky
**DATE STARTED** 8/15/24 **COMPLETED** 8/15/24
**GROUND ELEVATION** 718 ft **HOLE SIZE** 4"
**DRILLING CONTRACTOR** Strata Group
**GROUND WATER LEVELS:**
**DRILLING METHOD** Hollow Stem Auger
**AT TIME OF DRILLING** ---
**LOGGED BY** Hunter Hawkins **CHECKED BY** Joe Cooke, PE
**AT END OF DRILLING** --- Dry upon completion of drilling
**NOTES** Mostly Sunny, 80'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 | | TOPSOIL (7") | | | | | |
| | | Brown LEAN CLAY (CL), silty, with some fine organics and few black odixes, slightly moist, SOFT | SPT S-1 | 83 | 1-2-1 (3) | | |
| | | Light brown and gray LEAN CLAY (CL), silty, slightly moist, FIRM | SPT S-2 | 94 | 2-2-5 (7) | | |
| 5 | | Brownish gray and orange LEAN CLAY (CL), slightly layered, silty, with some fine sand and few gravel, moist, STIFF | SPT S-3 | 100 | 6-6-7 (13) | | |
| | | Brownish orange LEAN CLAY and GRAVEL (GC), silty, moist, HARD | SPT S-4 | 89 | 6-34-15 (49) | | |
| | | Weathered SANDSTONE | | | | | |

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

Refusal at 8.6 feet.
Bottom of borehole at 8.6 feet.

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# BORING NUMBER B-8

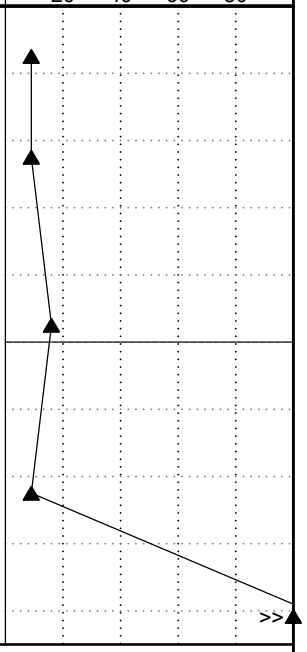


**CLIENT** MSE
**PROJECT NAME** Rowan County Senior Citizens Center
**PROJECT NUMBER** 1776-23-0138
**PROJECT LOCATION** Morehead, Kentucky
**DATE STARTED** 8/15/24 **COMPLETED** 8/15/24
**GROUND ELEVATION** 718 ft **HOLE SIZE** 4"
**DRILLING CONTRACTOR** Strata Group
**GROUND WATER LEVELS:**
**DRILLING METHOD** Hollow Stem Auger
**AT TIME OF DRILLING** ---
**LOGGED BY** Hunter Hawkins **CHECKED BY** Joe Cooke, PE
**AT END OF DRILLING** --- Dry upon completion of drilling
**NOTES** Mostly Sunny, 80's
**AFTER DRILLING** ---

| DEPTH (ft) | MATERIAL DESCRIPTION | SAMPLE TYPE NUMBER | RECOVERY % (RQD) | BLOW COUNTS (N VALUE) | POCKET PEN. (tsf) | DRY UNIT WT. (pcf) |
|---|---|---|---|---|---|---|
| 0 | TOPSOIL (4") | | | | | |
| | PREVIOUSLY PLACED FILL: Grayish brown LEAN CLAY (CL), with some organics, silty, moist, STIFF | SPT S-1 | 100 | 2-5-4 (9) | | |
| | Light brown and gray LEAN CLAY (CL), silty, slightly moist, STIFF | SPT S-2 | 100 | 4-5-4 (9) | | |
| 5 | Brownish orange and gray LEAN CLAY (CL), silty, slightly moist, STIFF | SPT S-3 | 94 | 5-8-8 (16) | | |
| | Gray and brown LEAN CLAY (CLS), sandy and silty, moist to very moist, STIFF | SPT S-4 | 100 | 4-5-4 (9) | | |
| | Brownish gray and orange LEAN CLAY (CL), slightly layered, silty, with some fine sand and few gravel, moist, STIFF | SPT S-5 | 50 | 50/2" | | |
| | Weathered SANDSTONE | | | | | |

Refusal at 9.5 feet.
Bottom of borehole at 9.5 feet.

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



Cooke Engineering and Testing Company

# Laboratory Testing Summary Table

| | | | |
|---|---|---|---|
| Project Name: | Rowan Co Senior Citizens Center | Date: | September 23, 2024 |
| Project Location: | Morehead, KY | Reviewed by: | Joe Cooke, PE |
| Client: | Rowan Co Fiscal Court | CETCO Project Number: | 1776-24-0138 |

| Sample ID | Depth (ft) | Natural Moisture Content (%) | Liquid Limit | Plastic Limit | Plasticity Index | % Finer than #200 Sieve |
|---|---|---|---|---|---|---|
| B-1 | 0.0-1.5 | 18.1 | | | | |
| B-1 | 1.5-3.0 | 18.6 | | | | |
| B-2 | 1.5-3.0 | 20.5 | 34 | 22 | 12 | 99.1 |
| B-2 | 4.0-5.5 | 24.3 | | | | |
| B-4 | 1.5-3.0 | 27.0 | | | | |
| B-4 | 4.0-5.5 | 15.9 | | | | |
| B-4 | 6.5-8.0 | 22.4 | 23 | 21 | 2 | 78.5 |
| B-4 | 9.0-10.5 | 24.3 | | | | |
| B-5 | 0.0-1.5 | 23.2 | | | | |
| B-5 | 1.5-3.0 | 21.4 | | | | |
| B-5 | 4.0-5.5 | 22.6 | | | | |
| B-7 | 1.5-3.0 | 21.0 | | | | |
| B-7 | 4.0-5.5 | 19.9 | | | | |
| B-8 | 1.5-3.0 | 11.2 | | | | |
| B-8 | 4.0-5.5 | 14.1 | | | | |
| | | | | | | |

Cooke Engineering and Testing Company

# Atterberg Limits Chart

| | | | |
|---|---|---|---|
| Project Name: | Rowan Co Senior Citizens Center | Date: | September 23, 2024 |
| Project Location: | Morehead, KY | Reviewed by: | Joe Cooke, PE |
| Client: | Rowan Co Fiscal Court | CETCO Project Number: | 1776-24-0138 |
| | | "Atterberg Limits", ASTM D4318 | |

| Sample ID | Depth (ft) | Natural Moisture Content (%) | Liquid Limit | Plastic Limit | Plasticity Index | % Finer than #200 Sieve |
|---|---|---|---|---|---|---|
| B-2, 1.5'-3.0' ▲ | 1.5-3.0 | 20.5 | 34 | 22 | 12 | 99.1 |
| B-4, 6.5'-8.0' ★ | 6.5-8.0 | 22.4 | 23 | 21 | 2 | 78.5 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

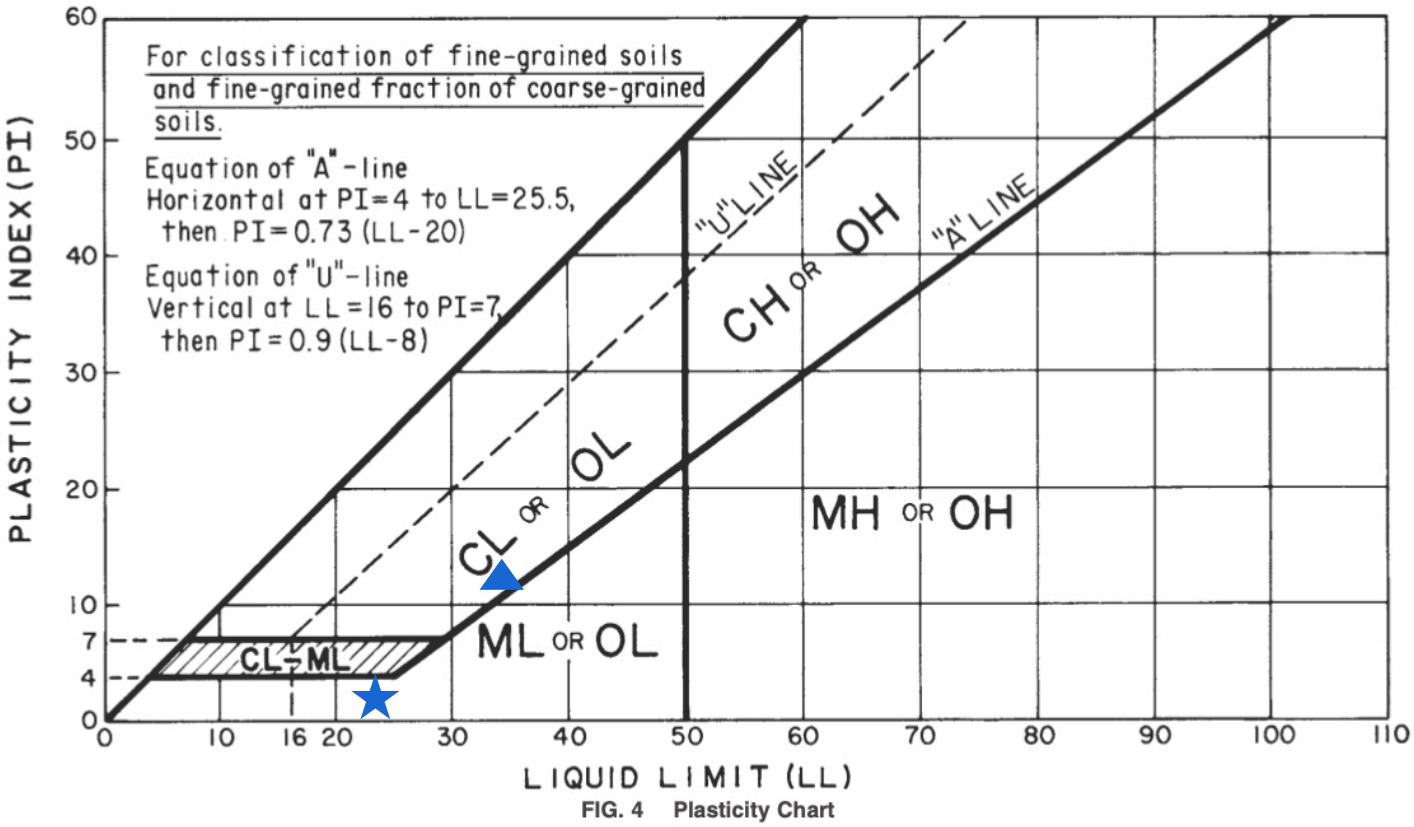



FIG. 4 Plasticity Chart

## 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**