

ADDENDUM NUMBER 1

**Leitchfield Water Treatment Plant
Leitchfield utilities Commission**

Bid Opening Date: November 15, 2018 at 2:00 PM local time
Date of Addendum: November 1, 2018

Bidders shall conform to the following changes as same shall become binding upon the Contract to be issued in response to the Invitation to Bid. The Contract Documents shall be revised and/or amended as set forth herein:

1. Geotechnical report attached.

END OF ADDENDUM NO. 1

Receipt of this Addendum must be acknowledged on the Bid Schedule.

By: Cann-Tech, LLC



Matthew Baker, P.E.
Project Manager



Geotechnical Report
for

Leitchfield Water Treatment Plant Expansion

Leitchfield, Kentucky
CSI Project Number LV170016

July 11, 2017

Prepared for
Cann-Tech, LLC
Leitchfield, Kentucky

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Geotechnical & Materials Engineering | IBC Special Inspection | Material Testing

July 11, 2017

Cann-Tech, LLC
1100 Glensboro Road, Suite 9
Lawrenceburg, KY 40342

ATTN: Mr. Larry Cann

Subject: **Report of Geotechnical Services**
Leitchfield Water Treatment Plant Expansion
Leitchfield, Kentucky
CSI Project Number LV170016

Dear Mr. Cann:

Consulting Services Incorporated of Kentucky (CSI) is pleased to present our report for the geotechnical services completed on the subject project. We provided our services in general accordance with the CSI Proposal Number 5142, dated June 2, 2017.

Our report represents information provided to us, readily available published data relevant to the site and site area, our observations and subsurface conditions encountered and our opinion of primary geotechnical conditions (discussion and recommendations) affecting design, construction and performance of the proposed earth and/or rock-supported portions of the project.

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

Cordially,

A handwritten signature in blue ink, appearing to read 'Will Harmon'.

Will Harmon, EIT, SI
Staff Professional



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

7-11-17
J.C.

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INTRODUCTION

1 SCOPE OF THE GEOTECHNICAL EXPLORATION

As we proposed, we conducted geotechnical services which are summarized in the following report. Our services included a review of the project information provided, conducting a subsurface exploration that utilized soil borings to obtain samples for modeling the soil/rock conditions at the subject site, an analysis of the data and information obtained and providing recommendations for the earth and/or rock-supported portions of the site as listed in our proposal. We provided a preliminary findings letter, dated June 29, 2017, summarizing our findings. This report, along with the letter, should be used in tandem for the project.

2 PROVIDED INFORMATION

Project information was provided via e-mail correspondence from you. We were provided with the following information:

- PDF plan set by Cann-Tech, LLC, entitled “Leitchfield WTP Preliminary”, dated January 2017, depicting the site plan, site details, and partial building elevations and layouts.

Based on the information obtained, the following is our understanding of the project:

- The project site is located off of Lewis School Road in Leitchfield, Kentucky.
- The site is grass covered and is adjacent to the existing Leitchfield Water Treatment Plant.
- The proposed project includes Pump house, Clearwell, Flocculators Settling basins and detention basin.
- Elevations of the top of foundation for some of the primary structures: Wet Well 609 ft., Flocculator / Settling Basin 625 ft., Bottom of trough in Filter Basins 629 ft., Piping Gallery trough 624 ft. and Clearwell 613 ft.
- Other site improvements include asphalt pavement for drive lanes and area parking.
- Deep foundations are required for the proposed structures.

We have not been provided with any foundation loading or traffic information for the project. Also, the site grading provided is only preliminary and may change. We have based our report on the following information:



Table 1. Summary of Anticipated Conditions	
Site Grading	
Finished Floor Elevation	Varies (approximately 609 to 629)
Maximum anticipated cut	up to approximately 22 feet
Maximum anticipated fill	less than 12 feet for mass grading
Maximum anticipated foundation excavation	22 feet
Anticipated Foundation Loading Conditions	
Load Type	Load
Column	<150 kips
Wall	<10 kips/LF
Office Floor Slab	<150 pounds per square feet
Equipment pad and structural loading	<3000 psf
Anticipated Traffic loading	
Parking and Roads	<250 cars per day
	< 5 Box trucks per week
	<2 Tractor trailers per month
	1 garbage truck per month

If any of the aforementioned information is in error or if the information changes during any time of the project, please contact our office so we can evaluate the new information with respect to our findings and recommendations.

3 AREA/SITE INFORMATION

3A AREA TOPOGRAPHY/PHYSIOGRAPHY

The site is located in the Pennyroyal physiographic region of Kentucky near the eastern boundary of the Western Kentucky Coal Field, specifically the Dripping Springs Escarpment. This region is characterized by a line of hills formed by isolated Pennsylvanian and Mississippian aged sandstone capping more erodible Mississippian aged shales and limestones. Published mapping indicates elevations in the site vicinity range from 640 feet to 620 feet. Below is a figure of the location of the site with respect to the regional physiography.



Figure 1. Kentucky Physiographic Map
(site vicinity shown in the circle)

3B SITE GEOLOGY

A review of the USGS McDaniels Geologic Quadrangle Map, Kentucky (dated 1978) indicates the project site is underlain by the Big Clifty Sandstone unit and the Haney Limestone unit near and to the south of Lewis School Road.

As mapped, the Big Clifty Sandstone unit is described as white to very light yellowish gray, very fine to medium grained, thin to massive bedded sandstone and iron stained. The Big Clifty Sandstone can be interbedded with medium dark gray and olive gray, clayey to silty shale. Siltstone can also be encountered in Big Clifty Sandstone consisting of medium gray and occurring in thin beds in basal and the uppermost parts and as scattered very small iron stained nodules.

As mapped, the Haney Limestone Member is located near the southern portion of the project site. This unit primarily lies outside of the project site, but its close proximity to the site merits mentioning some of the properties should limestone be encountered. The Haney Limestone unit is very light to medium gray, weathering to medium light gray to light olive gray, finely to medium crystalline. Chert lenses and ovoid nodules can also be present at this depth of the unit.

It should be noted that the subsurface conditions encountered during drilling operations and site observations were consistent with the data presented on the geologic quadrangles for Big Clifty Sandstone including weathered rock conditions and iron staining.

Additional items pertaining to the site geology include the following:

- The geologic mapping suggests that springs are common in the area.

- The Rough Creek fault system lies approximately four miles to the south of the project site.
- There have been a few attempts to drill for oil and gas in the quadrangle, but only slight shows of oil were reported.
- The geologic dip in the area of the project site is approximately 1 percent to the southwest. Below is a figure of the location of the site with respect to the area geology.

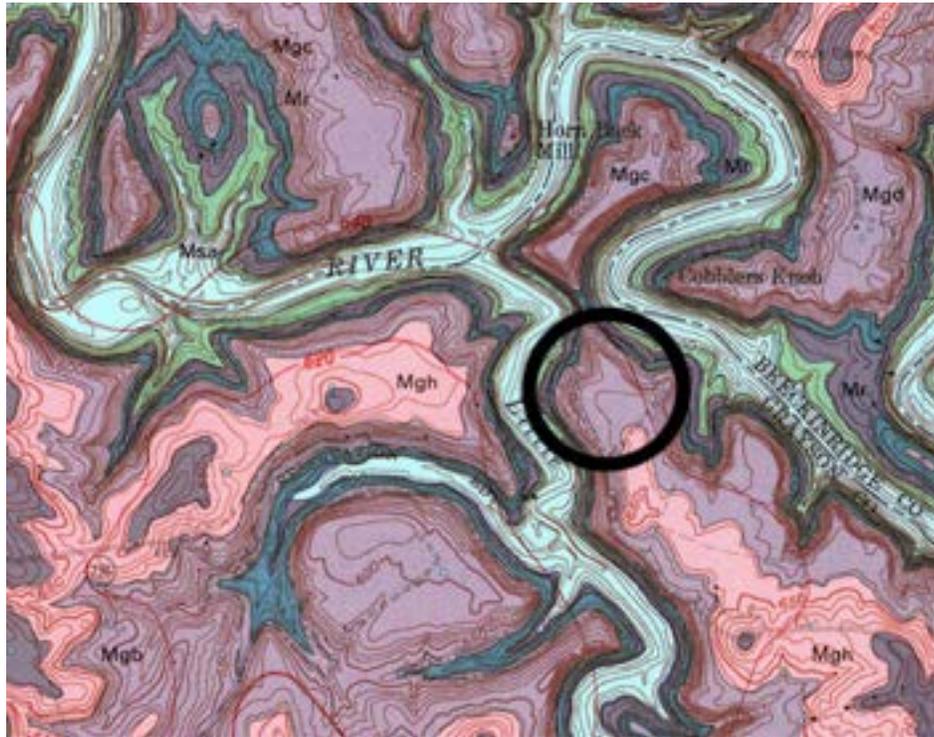


Figure 2. Site Geology (USGS McDaniels Geologic Quadrangle, dated 1978)
(site vicinity shown in circle)

As with most of the geology of this portion of Kentucky, karst (sinkholes, weathered bedrock, caverns, erratic bedrock, etc.) is associated with the site geology. The Grayson County Karst Areas map published by the Kentucky Geological Survey (KGS) indicates that the project site is in an area of intense karst. The following figure indicates the likelihood of karst occurrence.

Grayson County Karst Areas

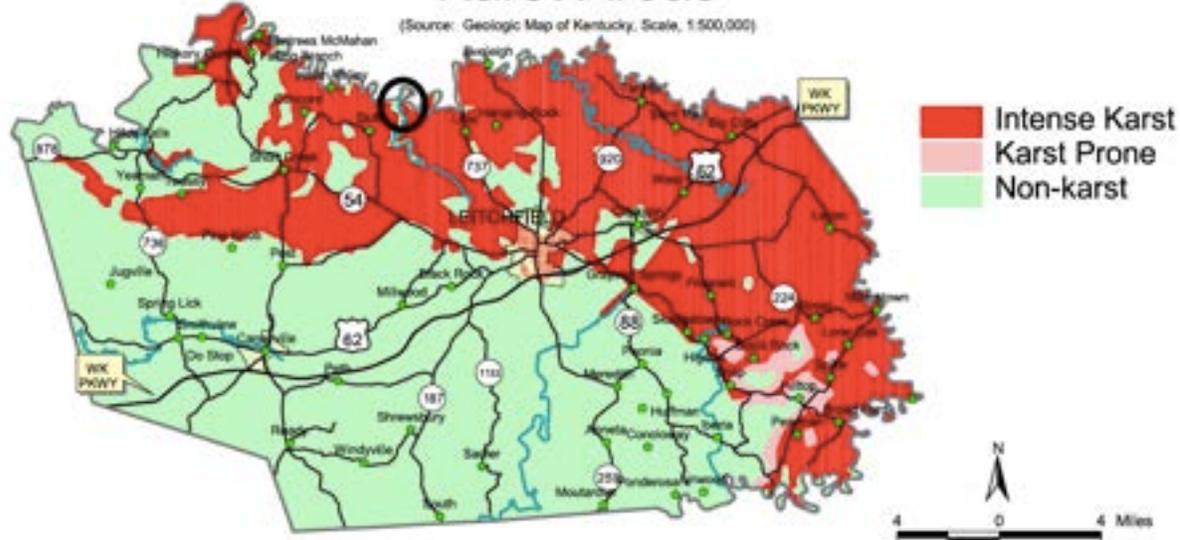


Figure 3. Grayson County Karst Areas Map, KGS
(site vicinity shown in circle)

3C PUBLISHED SITE SOIL CONDITIONS

According to the USDA Soil Survey of Kentucky (NRCS website), the soils underlying the site vicinity consist of the following series:

- Zanesville silt loam (ZaB) with 2 to 6 percent slopes for the northeastern two-thirds of the project site and 6 to 12 percent slopes on the southwestern side of the project site(ZaC).
- Depth to restrictive feature for these soil series are generally listed as 76 to 79 centimeters
- Depth to water table for these soil series are listed as 72 to 69 centimeters
- These soil series are generally listed moderately well drained
- These soil series are listed as very limited with respect to construction of dwellings with and without basements, shallow excavations and small commercial buildings. Particular issues affecting construction include depth to thick and thin cemented pan, depth to saturated zone and slope.

The issues mentioned that are pertinent to your site and project will be addressed in the latter sections of this report.



Below is the soils map from the USDA website.



Figure 4. USDA Soil Survey Map of Project Site

3D OTHER PUBLISHED SITE INFORMATION

We have reviewed several available aerial photographs, dated as far back as February of 1997. The project site is located off of Lewis School Road, in Leitchfield, Kentucky. Based on the reviewed photographs, no major changes occurred at the site or surrounding areas from February 1997 to September 2014, the most recent aerial photograph. Please reference the aerial photographs below for further details.



Figure 5. Aerial photo of the site area, dated February 27, 1997, from Google Earth (site shown encircled)



Figure 6: Aerial photo of the site area, dated November 12, 2004, from Google Earth (site shown encircled)



Figure 7: Aerial photo of the site area, dated August 30, 2010, from Google Earth (site shown encircled)



Figure 8: Aerial photo of the site area, dated September 24, 2014, from Google Earth (site shown encircled)



FINDINGS

4 SITE SURFACE OBSERVATIONS

A site reconnaissance was conducted by Mr. William Harmon, EIT, of CSI on June 26 and 27, 2017. Mr. Harmon observed and documented site surface conditions, logged soil borings and rock cores, and directed drilling operations.

The project site is located off of Lewis School Road, bordered to the west by Little Clifty Creek and to the east by Rough River. The site is located approximately sixty feet above Little Clifty Creek. Lewis School Road is located to the southeast of the site. Rough River lies to the northeast of the site but was not visible from the site.

In general, the site topography consists of a grass lawn on top of a knob with steep slopes away from the site particularly on the west side of the site. The site itself has a change in elevation of approximately fifteen feet (with respect to our top of boring elevations) mildly sloping from the high ground in the northeast to the cliff on the western side of the project site. The existing water treatment plant is on the northern side of the project site. The northeastern side of the site is relatively level in the area of the existing gravel road.

At the time of our site visit, the site ground cover consisted of grass. A gravel road running north to south leads to the existing water treatment plant on the western side of the project site. A grass covered gravel road running north to south lies between the proposed structures and the proposed driveway. This road leads to a shed on the north side of the project site.

Underground utilities were marked within the limits of the site leading from the existing water treatment plant. Overhead utilities running north to south near the gravel road bisecting the proposed project site. The photos below show the site conditions at the time of our visit.



Photo 1. View of site from Lewis School Road facing northwest towards the existing water treatment plant



Photo 2. View from the entrance road to the water treatment plant with the proposed project site to the east



Photo 3. View of western border cliff drop off to Big Clifty Creek



Photo 4. View of site facing south towards Lewis School Road from the existing water treatment plant



Photo 5. View of site facing south towards Lewis School Road from the existing water treatment plant with the grass covered gravel road on the left in the photo with overhead utilities

5 SUBSURFACE CONDITIONS

We utilized 14 soil test borings with 3 of these having rock cores to explore the subsurface conditions at the site. Ten soil borings were performed within the footprints of the proposed structures (labeled B-201 through B-208, B-103 and B-104). The remaining four borings (labeled B-101, B-102, B-301 and B-302) were taken in the proposed driveway and detention basin areas. Five foot rock cores were collected near the proposed clear well (B-103) and the proposed flocculation and settling basins (B-208). A twenty foot rock core (B-201) was collected near the proposed wet well location. In general, we encountered topsoil/rootzone, overlying residual soils, overlying weathered sandstone (when encountered), overlying bedrock. The following table summarizes the general depths of our borings.



Boring Number	Depth to Refusal (ft)*	Total Depth (ft)*
B-101	2	2
B-102	4	4
B-103	4	9
B-104	6	6
B-201	6	26
B-202	5	5
B-203	10	15
B-204	10	10
B-205	9	9
B-206	10	10
B-207	7	7
B-208	8	13
B-301	N/A	6
B-302	N/A	6

Table 2. Boring and Sounding Information Summary
 * boring depths were rounded to the nearest whole foot

5A STRATA INFORMATION

The subsurface conditions encountered at the boring locations are shown on the Test Boring Records in Appendix A. These Test Boring Records represent our interpretation of the subsurface conditions based on the field logs, visual examination of field samples by an engineer, and tests of the samples collected. The letters in parentheses following the soil descriptions are the soil classifications in accordance with the Unified Soil Classification System. It should be noted that the stratification lines shown on the soil boring logs represent approximate transitions between material types. In-situ stratum changes could occur gradually or at slightly different depths. Water levels shown on the Test Boring Records represent the conditions only at the time of our exploration.

The general subsurface conditions are summarized in the following table:

Strata	Thickness	Notes
Surface Cover: Topsoil/Rootzone	6 to 10 inches	Present in all borings
Residual: Lean Clay, light reddish brown, firm to very stiff, sandy, moist	1 to 10 feet	Present in all borings
Residual: Fat Clay, reddish brown and brown, firm to stiff, sandy, moist	3+ feet	Present in boring B-301 and likely to be encountered at similar depths across the site
Sandstone		Present in all rock cores

Table 3. General Subsurface Strata

Auger refusal was encountered in all soil borings except for the two soil borings performed in the proposed driveway to the east of the project site. These borings (B-301 and B-302) were terminated at a depth of approximately six feet. Auger refusal depths ranged from approximately 2 to 10 feet. We have interpreted auger refusal to be the top of hard bedrock. Refusal material was sampled by coring rock at borings B-201, B-208 and B-103. The rock cores are summarized below.

Boring	Run	Description and Notes	Photo of Core
B-103	1: from 3.8' to 8.8'	<p>Sandstone - light yellowish gray to light olive gray to light yellowish brown, very fine to medium grained</p> <p>Recovery: 100% RQD: 33% (poor engineering quality)</p>	

Table 4. Rock Core Summary
(Top of rock core shown in picture is at the upper right corner of the photo)

Boring	Run	Description and Notes	Photo of Core
B-208	1: from 8.1' to 13.1'	<p>Sandstone - light yellowish gray to light olive gray to light yellowish brown, very fine to medium grained</p> <p>Recovery: 97% RQD: 43% (poor engineering quality)</p>	

Table 5. Rock Core Summary
(Top of rock core shown in picture is at the upper right corner of the photo)



Boring	Run	Description and Notes	Photo of Core
B-201	1: from 6' to 16'	Sandstone - very light yellowish gray to very light olive gray to light yellowish brown, very fine to medium grained Recovery: 98% RQD: 54% (fair engineering quality)	
	2: from 16' to 26'	Sandstone - very light yellowish gray to very light olive gray to light yellowish brown, very fine to medium grained Recovery: 100% RQD: 63% (fair engineering quality)	

Table 6. Rock Core Summary
 (Top of rock core shown in picture is at the upper right corner of the photo)

For details of subsurface conditions encountered at a particular boring location please refer to the boring logs contained in Appendix A. It should be noted that our borings were drilled and sampled according to the procedures presented in the appendix. Our field personnel located the borings by means of hand taping and estimating right angles from existing site features and property lines. Boring elevations were established by means of rod and level, and referenced to the rectangular equipment pad adjacent to the existing water treatment plant. We assumed an elevation of 100.00 feet. The boring locations shown in the appendix should be considered accurate only to the degree implied by the method used.

5B GROUNDWATER CONDITIONS

No free water was observed in our soil borings at completion of soil augering. Groundwater level readings were not taken in borings B-201, B-208 and B-103 (where rock coring was performed) after coring since water was used to cool the rock coring bit. No water loss was noted while coring. The borings were immediately filled upon their completion due to safety concerns. Please be aware that



borings may experience some settlement over time, thus they should be monitored and backfilled to grade as necessary. The USDA soil survey indicates shallow depth to water. The geologic quadrangle supports this further stating springs are common in the Golconda Formation at the base of the Haney Limestone Member. In this part of Kentucky, water conditions that usually affect construction and performance of projects consist of trapped/perched water zones which occur in variable areas in the soil mass, at or near existing or former structures, at or near the bedrock bedding planes, or at or near the soil/rock interface. Perched water sources are often not linked to the more continuous relatively stable ground water table that typically occurs at greater depths. Finally, water issues are also dependent upon recent rainfall activity and surface and subsurface drainage patterns in the area.

6 LABORATORY TESTING

Laboratory tests were performed on selected recovered samples from our borings. Details for the test methods and results are shown in the appendix. The tests include obtaining data for estimating soil shear strengths, and compressibility, and to provide moisture/density data for earthwork. Detailed descriptions of these tests and the results of our testing are included in the appendix. Tests performed included:

- 30 natural moisture content tests
- 4 Atterberg limits tests
- 4 Percent Finer than #200 Sieve tests
- 3 unconfined compression test (soil)
- 1 unconfined compression test (rock)
- 1 standard Proctor

GEOTECHNICAL DISCUSSION AND RECOMMENDATIONS

7 DISCUSSION-GEOTECHNICAL ISSUES

Based on our experience with similar projects and the conditions observed during our subsurface exploration, we believe the site is suitable for the proposed development. The primary geotechnical concerns are:

- **Shallow and Varying Depth to Bedrock**
- **High Plasticity Soils**
- **Karst**
- **Potentially Wet Zones**

The following sections discuss each issue. However, recommendations to address the issues are contained in later sections of the report.

7A SHALLOW AND VARYING DEPTH TO BEDROCK

Our borings encountered auger refusal at depths ranging from approximately 2 feet to 10 feet. Therefore, shallow rock will likely impact the project. The bedrock as cored is “medium” hardness.



However rock removal techniques such as blasting and hoe-ramming will be required to remove the bedrock (other than the upper one foot or so.)

Project foundations bearing on both soil and rock can have an elevated risk for differential settlement. Due to the depth of the structures that are proposed for the site, it is likely that they will mostly be built on rock bearing foundations.

Also, underground pipe runs will likely encounter rock in excavated trenches.

Soils are typically soft and wet at or near the soil-rock interface. These soft/wet soils could increase the likelihood of poor structural performance.

7B HIGH PLASTICITY SOILS

Our laboratory testing indicates soils with high plasticity, “fat clays” (CH), are present on this project site. Four Atterberg limits tests were performed on soil samples from the borings. One of these samples classified as a fat clay (CH). The fat clay sample collected from boring B-301 had a liquid limit of 68 with a plasticity index (PI) of 44. Soils with a PI above 30 can have a tendency to shrink/swell with changes in moisture content. A swell test was not included in our scope of work, thus we do not know to what extent the fat clays on-site will swell when they become wet.

Shrinking and swelling of foundation and bearing soils are generally not as severe in this region of Kentucky as in other regions because long periods of excessively wet or dry weather do not normally occur. However, if site grading takes place during the dry summer or fall months, significant drying of the exposed subgrade soils may occur. If these soils resaturate after completion of construction, structural distress may be experienced. Therefore, the volume change potential of the soils should be considered and the following precautions are recommended.

Highly plastic clays are subject to volume changes with fluctuations in moisture content, and to significant strength loss with increases in moisture content. Volume increases are typically accompanied by swelling pressures sufficient to raise building foundations and floors. Moisture content loss typically results in settlement of soil supported building components. Where the soil moisture fluctuates, movement may be on-going throughout the building’s life, resulting in deterioration and building distress. Strength loss may also affect building components, but is more likely to adversely affect parking lots; especially flexible asphalt pavements. Accumulation of water beneath pavement structures, followed by repeated traffic loads, may result in the failure of both pavement and the subgrade materials.

Methods to control the adverse effects of these soils include providing efficient drainage around buildings and pavements, and installation of foundation components at depths below levels where moisture contents are subject to significant fluctuation. Specific recommendations to minimize the effects of these soils on the proposed development appear in the recommendation sections of the report.

7C KARST

The site is located in an area with high potential for karst development. The available geologic data also suggests that sinkholes are commonly associated with the potential limestone formation underlying portions of the site. Karst features such as sinkholes, dropouts, weathered bedrock, caverns, erratic bedrock, etc. are typically exposed during grading activities and foundation and/or utility construction. Karst topography consists of limestone or dolomite that is weathered which results in sinkholes (i.e. - closed depressions), irregular top of rock profiles, pinnacled bedrock, slots or troughs in the bedrock,



internal drainage systems, and open voids in either the bedrock itself or in the soil overburden (typically at the soil/rock interface). Additionally, soft/wet soils are commonly encountered at the soil/rock interface and in slots or troughs in the bedrock. It should be noted that no signs of karst were readily apparent from our visual observations or were present in our soil samples or auger cuttings. Furthermore, the rock coring that was conducted did not encounter limestone. However, the Southern edge of the project site is at the bottom of a limestone member and the possibility for karst activity still remains a risk.

An in-depth karst study was beyond the scope of this exploration. Procedures for construction in karst areas are contained in later sections of the report. Regardless of methods used, they should be treated on a case-by-case basis and should involve a CSI geotechnical engineer. Based on our knowledge of the area geology, sinkholes could be exposed during grading activities and foundation/underground utility construction. Detailed site proofrolling and foundation observations are frequently utilized in an attempt to locate incipient soil dropouts. Sinkholes must be evaluated and treated on an individual basis. A CSI geotechnical engineer should be retained for remediation recommendations if a sinkhole is exposed during construction. Treatment of depressions will likely involve monitoring by a CSI geotechnical engineer during earthwork operations to observe indications of sinkhole throats and conduits after stripping of topsoil and soil cutting activities are complete. Procedures for repairing sinkholes or other karst features should be done on a case-by-case basis and should involve a CSI geotechnical engineer.

7D POTENTIALLY WET ZONES

No freewater was encountered in any of our borings. However, the site soil survey and the geologic quadrangle both indicate that shallow water conditions could exist at the project site, especially at the base of the Haney Limestone unit where springs are known to exist. Saturated zones can be expected on the site, especially in the months of January to April or during extended periods of wet weather. Typically, undercutting soft/wet soils is not advisable as the site conditions are conducive to shallow water conditions. The wet conditions will likely make the surrounding soils soft, which also includes some amount of the overlying soils (existing and new fill). Contingencies should be considered as the use of sumps or french drains may be needed during the earthwork portion of the project. Because wet conditions are sometimes not known until they are encountered, CSI should be retained for additional recommendations. It is likely that above average de-watering methods will be required.

8 EARTHWORK

Historically, more change orders (in total number and costs) occur during the earthwork portion of construction than in almost any other part of the project. Further, the site preparation phase of construction always affects the future performance of project structures and pavements. Add into this, the fact that earthwork is the portion of work most influenced by wet weather and unknown conditions and time-wise, this section of the report could be the most important to prevent and minimize delays and costs during construction and for the life of the project.

Please review the concerns listed in section 7 prior to reading the following recommendations. If problems occur that the recommendations do not address or do not adequately remedy, please contact CSI as soon as possible.

8A SITE PREPARATION (WORK PRIOR TO FILLING)

- DO NOT OVERSTRIP THE SITE SOILS - this may lead to excessive destabilization of the upper site soils;



- When ready to commence construction, topsoil and obvious 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 proofrolled with a heavily loaded dump truck or similar equipment judged acceptable by the geotechnical engineer;
- The level of proofroll should be determined by the geotechnical engineer on a case-by-case basis;
- Perform the proofrolling after a suitable period of dry weather to avoid degrading the subgrade;
- Areas which pump, rut, or wave during proofrolling may require undercutting, depending on the location of the area and the use of the area, so the geotechnical engineer should be contacted for guidance;
- Backfill of undercut areas should be done in accordance with sections 8B and 8C;
- Remove deleterious materials, former structures and materials that are unsuitable for use in supporting the overlying new fill. These include, but are not limited to: abandoned utilities, older pavement materials, gravel, old fill, etc. Again, the backfill should be consistent with the requirements listed in sections 8B and 8C;
- Retain CSI to observe the proofrolling operations and make recommendations for any unstable or unsuitable conditions encountered---this can save time on the construction schedule and save unnecessary undercutting.
- Wet conditions are likely at the site, especially within a few feet of the bedrock / soil interfaces. Project budgets should have contingencies for dewatering such as sumps, french drains or similar methods.
- Please refer to the Karst Region Construction recommendation section (Section 13);

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.

8B NEW FILL OPERATIONS (MASS 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.

After the subgrade has been approved to receive new fill, the fill may commence with the following procedures and guidelines recommended:

- Place fill in maximum 8-inch thick loose lifts;
- Fill lifts should be compacted to at least 98 percent of the soil's maximum dry density (ASTM D 698) under building areas and at least 95 percent under sidewalks and pavements;
- Due to the presence of high plasticity soils on-site, the moisture content of compacted fill should be maintained at optimum to plus 3 percent of the soil's optimum moisture;



- Non-structural areas (outside 5 feet from a structure or 2 feet from a pavement area) can utilize a lower compaction requirement of 90 percent;
- Building and roadway (or other critical structures) fill compaction requirements should extend to at least 5 feet outside the structure perimeter;
- All new fill material should be tested for plasticity by CSI;
- Soils with a plasticity index (PI) of greater than 40 should not be used in the upper 4 feet of new fill;
- If the soils tested at that time have PIs greater than 40, CSI will provide recommendations at that time;
- Maximum particle size of the soil should be limited to 8 inches in any dimension;
- Density testing should be performed as a means to verify percent compaction and moisture content of the material as it is being placed and compacted;
- Observation of fill “stability” is also critical, so it is recommended to observe the operation of the filling equipment traversing over the new fill to document movement (similar to proofrolling);
- Density testing should be performed at a rate of at least one per 10,000 square feet per lift with a minimum of 3 tests per lift;
- Soils should not be “overcompacted” and construction traffic should be kept to minimum to assure compaction is achieved and that the soil is not allowed to “break down”;
- Retain a representative of CSI to observe and document fill placement and compaction operations.

8C BACKFILL OPERATIONS (FOUNDATION WALLS, UTILITIES, ETC.)

These materials are placed in more confined areas than mass earthwork materials or pavement materials and therefore cannot be placed in full compliance with sections 8A or 8B. The following are general recommendations for backfill areas:

- Fill lift thicknesses will vary dependent on compaction equipment available and material types, but in no case should exceed 8 inches;
- CSI recommends using soil fill as backfill. Use of stone backfill would allow water to collect at the bottom of the excavation and potentially activate a latent Karst feature;
- If crushed stone/aggregate is utilized as backfill in trenches or wall backfill or when using smaller compaction equipment (such as a plate compactor or trench compactor or similar) the lift thickness should not exceed 4 inches;
- Compaction/moisture percentages and density testing frequency should be the same as in section 8B;
- CSI should be retained to provide addition recommendations for backfill.



8D GENERAL NOTES

- 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;
- If any soil placement problems occur, CSI should be retained to provide additional recommendations, as needed.

9 SITE DRAINAGE AND DEWATERING

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. Structure roof drains should be piped away to 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. Proper storm water drainage is critical to avoid increasing risk of sinkhole development. CSI should be allowed to review the final site civil drawings to ascertain any elevated risk associated with civil designs.

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. The site soil survey indicates that the on-site soils in their natural state are well drained but the soils are noted to have “shallow depth to saturated zones.” Further, the site geology states that springs are common in the area especially within a few feet of the bedrock / soil interface. Project budgets should have contingencies for dewatering such as sumps or french drains. Thus, we anticipate above average dewatering measures will be necessary for this project. CSI should be retained during construction to provide guidance as conditions arise.

10 FOUNDATIONS

Due to shallow rock encountered and the deep foundations required for many of the structures, we believe that the majority of the project foundations will be rock bearing. CSI must be retained to check foundation bearing conditions for the structures as well as for ascertaining possible karst conditions in the foundation excavations. If there are any changes in the project criteria, CSI should be allowed to review the recommendations to determine if any modifications are required.

10A SHALLOW FOUNDATIONS (SOIL BEARING)

Although we anticipate that the majority of the foundations will be rock bearing, some foundations may bear on soil where elevations allow. However, a CSI geotechnical engineer must verify all foundation excavations for acceptance and provide recommendations for treatment of any unsuitable conditions encountered.

For project foundations bearing on residual soils or newly and properly compacted fill, shallow spread footings may be sized using a maximum allowable bearing pressure of 2,500 pounds per square foot (psf).

Detailed settlement analysis is beyond the scope of this exploration. Based upon the anticipated behavior of soil types encountered during field activities, and our experience with similar projects, we expect that total settlements will not exceed 1 inch, and that differential settlements will not exceed



1/2 inch between columns or along continuous footing distances of 30 feet or less. We recommend the structure be designed to accommodate this magnitude of total and differential settlement.

Settlement estimates are based, in part, upon the assumption that site preparation is performed in accordance with our recommendations and with good quality control of the earthworks.

Additional design considerations for project foundations are outlined as follows:

- Design all footings with a minimum 24 inches width;
- For soil bearing footings, all exterior footing bottoms should bear at least 36 inches below finished exterior grading;
- Spread foundations bearing on bedrock are not subjected to a minimum frost embedment depth or fat clay concerns and may bear at nominal depths.
- Interior footings (those not exposed to freezing) may be placed at nominal depths;
- Include control joints at suitable intervals in the walls of structures and in areas where changes in support from native soil to fill are anticipated, to help accommodate differential foundation movements.

10B SHALLOW FOUNDATIONS (SOIL BEARING) - CONSTRUCTION NOTES

Any soils can lose strength if they become wet, so we recommend the foundation subgrades be protected from exposure to water. For foundations construction, we also recommend the following procedures.

- For soils that will remain exposed overnight or for an extended period of time, place a "lean" concrete mudmat over the bearing areas. The concrete should be at least 4 inches thick. Flowable fill concrete or low-strength concrete is suitable for this cover, as conditions allow;
- Disturbed soil should be removed prior to foundation concrete placement;
- Foundation bearing conditions should be benched level;
- Areas loosened by excavation operations should be recompact prior to reinforcing steel placement;
- Loose soil, debris, and excess surface water should be removed from the bearing surface prior to concrete placement;
- Retain the geotechnical engineer to observe all foundation excavations and provide recommendations for treatment of any unsuitable conditions encountered.
- A CSI geotechnical engineer must verify all foundation excavations for acceptance and provide recommendations for treatment of any unsuitable conditions encountered.
- Even though fill soils placed for foundation support have likely been checked for compaction at the time of placement, these soils may have become wet or lost



some level of strength since that time. The areas should be hand probed to check for surface hardness/strength.

10C SHALLOW SPREAD FOOTINGS (ROCK BEARING)

As previously stated, we expect the majority of the project foundations will bear on rock. For foundations bearing completely on bedrock, spread foundations may be sized using a maximum allowable bearing pressure of 5,000 pounds per square foot (5 ksf). Any existing fill, residual soil, or weathered rock should be excavated until competent rock is exposed in the bottom of the foundation excavation. We interpret competent rock by observing the teeth of the backhoe or trackhoe being dragged vertically across the top of exposed rock. For foundations encountering rock at relatively greater depths, the excavation can be backfilled to normal bottom of footing elevation with lean concrete (2,000 psi minimum) or flowable fill (300 psi minimum).

A detailed settlement analysis was beyond the scope of this exploration. However, based on the expected structural loads and foundations bearing on competent bedrock, we expect both total settlements and differential settlements will not exceed 1/4 inch between columns or along continuous footing distances of 30 feet or less.

Additional design considerations for spread foundations bearing on bedrock are outlined as follows:

- Design all footings with a minimum 18 inches width;
- Spread foundations bearing on bedrock are not subjected to a minimum frost embedment depth.

10D FOUNDATIONS EMBEDDED IN ROCK AT LEAST 2' (ROCK BEARING)

Some structures may require a large amount of rock removal to achieve required bearing elevations. For foundations embedded two feet or more into bedrock, spread foundations may be sized using a maximum allowable bearing pressure of 20,000 pounds per square foot (20 ksf).

A detailed settlement analysis was beyond the scope of this exploration. However, based on the expected structural loads and foundations bearing on competent bedrock, we expect both total settlements and differential settlements will not exceed 1/4 inch between columns or along continuous footing distances of 30 feet or less.

Additional design considerations for spread foundations bearing on bedrock are outlined as follows:

- Design all footings with a minimum 18 inches width;
- Foundations embedded in bedrock are not subjected to a minimum frost embedment depth.

10E ROCK BEARING FOUNDATIONS - CONSTRUCTION NOTES

For rock bearing foundations, we also recommend the following procedures.

- Loose soil, mud, debris, and excess water should be removed from the bearing surface immediately prior to concrete placement.



- Foundation bearing surfaces should be benched to provide nearly-level bearing surfaces.
- A CSI geotechnical engineer must verify all foundation excavations for acceptance and provide recommendations for treatment of any unsuitable conditions encountered.

11 GRADE SUPPORTED FLOOR SLABS

A grade supported floor slab is suitable for the proposed structures, provided the subgrade is prepared according to the recommendations contained within this report. An increased risk of shrink/swell should be expected with the soils in cut areas and with on-site fill material. We recommend using free floating floor slabs to reduce the risk associated with the high plasticity soils. No turned-down slabs, thickened slab sections, or hard floor coverings should be used for this project. We recommend that the grade supported slabs be placed on a layer of crushed stone. The thickness of the crushed stone should be determined by the structural engineer; however, we recommend a minimum thickness of 4 inches beneath grade supported slabs.

Due to the presence of high plasticity soils on-site, we recommend that the moisture content be checked (in the area of the floor slabs) immediately prior to slab placement. It may be necessary to re-wet and re-compact these areas in order to reduce the likelihood of swell associated with these high plasticity soils.

- Provide isolation joints between the slab and columns and along footing supported walls.
- Adequate joint patterns (ACI and KBC guidelines) should be used to permit slab movement due to normal soil settlement, normal subgrade disturbance and material expansion/contraction.
- Place a minimum of 4 inches of clean, compacted gravel or crushed stone beneath the slab to provide a working base. The actual thickness of the gravel layer should be based on design requirements.
- 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 CSI to review the actual subgrade conditions prior to slab construction and make recommendations for any unsuitable conditions encountered.
- Note: Slab subgrade conditions are also considered earthwork areas and the recommendations contained in the Earthwork section of the report.

12 SEISMIC SITE CLASSIFICATION

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. Our site classification is based on the soil conditions and average depth of rock encountered during our subsurface exploration.

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, and surface rupture due to faulting or lateral spreading resulting from earthquake motions is low.

13 KARST REGION CONSTRUCTION RECOMMENDATIONS

- Typically the risk of sinkhole drop-out formation is reduced in filled areas and increased in cut areas. Designing the project foundations so that they are constructed to the greatest extent from bedrock is preferable from a sinkhole risk standpoint.
- Water flow considerations (both surface and subsurface) are a key factor to try to reduce karst associated risks when planning. CSI should be retained to assess civil plans of water flow to provide guidance with regards to potential increases to karst risks.
- Deep excavations should be observed after planned bottom of foundation elevation is reached to identify possible karst activity.
- If a sinkhole/dropout is encountered, the most effective repair method is usually to excavate to bedrock, and then construct a suitable concrete "plug" or inverted rock filter over the bedrock opening. However, a CSI geotechnical engineer should be consulted before performing any repairs.
- Specific procedure used to repair drop-outs will depend on the specific condition encountered. A CSI geotechnical engineer should be contacted if drop-outs form or suspect old drop-outs are encountered.

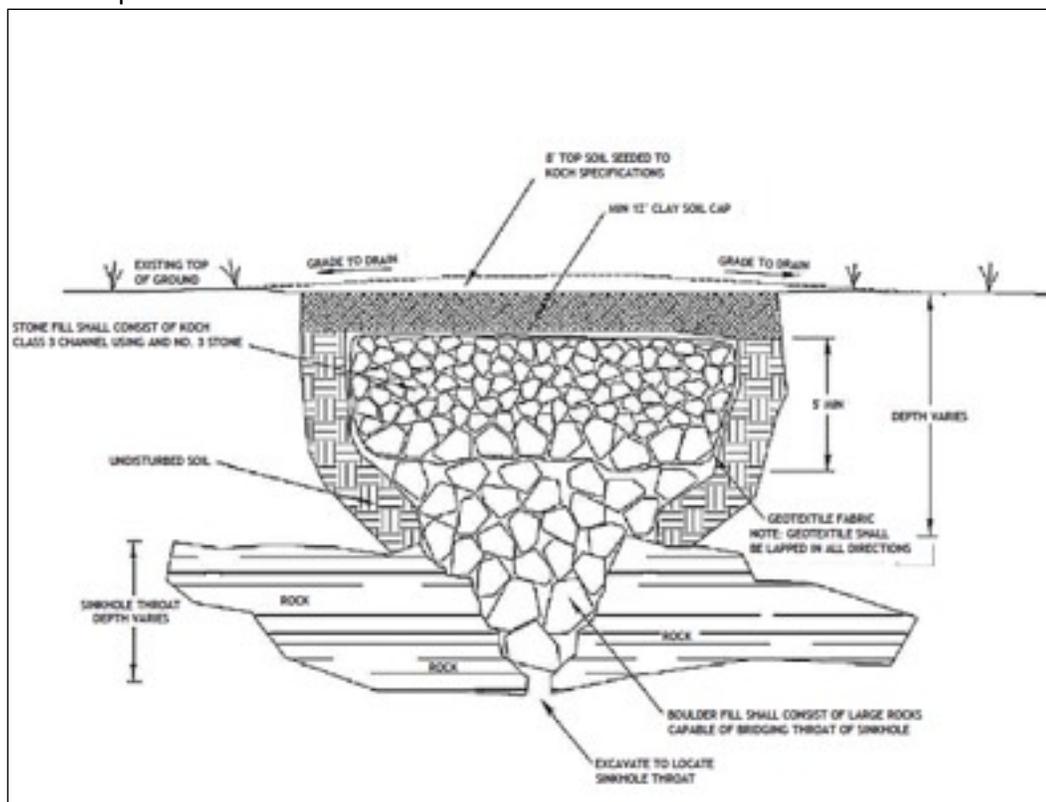


Figure 9. Sinkhole Repair Detail



14 BELOW GRADE STRUCTURES

As previously mentioned, the project will include several below grade structures. We recommend that the structural engineer contact our office to discuss their design intent for the below grade structures/walls. Specific recommendations can then be applied based on loading conditions. The following general list of recommendations should be applied for the at-rest earth pressure condition. In any case, the structure walls should also be designed to provide sufficient drainage at the rear of the wall to relieve hydrostatic pressure.

We recommend the walls be backfilled using a compacted granular material. The granular material should be clean, free draining, and exhibit an angle of shear resistance of 30 degrees or more. KDOH (KYTC) No. 57 stone is suitable for this purpose.

To utilize the following granular material earth pressure values, the granular material must occupy a triangular shaped minimum backfill zone. The minimum zone starts at the base of the wall from the outside face of the footing. At the top of the backfill, the zone should extend from the edge of footing a distance of three-fifths of the backfill height. In any case, stone backfill should be placed a minimum of 2 feet behind the wall and to at least 2 feet from the top of the wall.

The backfill zone may be drained using a perforated pipe placed at the base of the footing. Either gravity drainage or a sump pump system should be used to remove accumulated water. Adequate weeps should also be installed to assist in draining excess moisture.

A minimum thickness of two feet of low plasticity clay should be provided on top of the granular wall backfill material where the backfill material will be exposed to the weather.

The following table presents granular backfill, earth pressure design parameters for Equivalent Hydrostatic Pressures (EHP) and Earth Pressure coefficients. The values given assume the backfill surface is level, the backfill is drained, the zone of backfill conforms to the minimum zone size given above, and no surcharge is placed on the backfill.

Table 7. Granular Material Equivalent Hydrostatic Pressures (EHP) and Earth Pressure Coefficients		
Condition	EHP (pcf)	Coefficients
Active	40	$K_a = 0.33$
At Rest	65	$K_o = 0.5$
Passive	400	$K_p = 3.0$

Temporary soil excavation slopes during construction should be maintained at a maximum one horizontal to one vertical (1H:1V) slope (less than one day). In any event, all temporary slopes should be in compliance with OSHA and any other applicable safety regulations.



During construction, temporary slopes should be regularly evaluated for signs of movement or unstable conditions. Soil slopes should be covered for protection from rain, and surface runoff should be diverted away from the slopes.

15 PAVEMENT RECOMMENDATIONS

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 and to assist in identifying potential sinkholes/dropouts. Recommendations for undercutting/repair of the subgrade can be made at that time by the geotechnical engineer or their representative. 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.

The following pavement recommendations are based on our experience with similar materials and the anticipated loading conditions. The recommendations are based on the assumption that the soil subgrade will be compacted according to the recommendations contained in this report.

15A ASPHALT PAVEMENT

Our recommended pavement sections are based on anticipated traffic loads (as no design traffic loads were provided to us). We anticipate that the parking stalls and driving lanes will be composed of light duty asphalt. Based on the provided information, we do not expect any heavy duty asphalt for this project. The following pavement section should be reviewed by your civil engineer to verify its applicability for this project.

Table 8. Asphalt Pavement Section	
Pavement Section Component	Thickness (in)
Bituminous Surface Course	1.5
Bituminous Binder Course	2
Dense Graded Aggregate (DGA)*	8.0

*DGA to be placed in 6 inch thick maximum, compacted lifts

The asphaltic concrete should be mixed, placed, and compacted in accordance with Kentucky Department of Highways Standard Specifications. Also, the dense graded aggregate (DGA) should be placed and compacted in accordance with Kentucky Highway Specifications.

Note: Project entrance areas (within 50 feet of the entrance) should have either one additional inch of asphalt or two additional inches of DGA.

15B RIGID PAVEMENT

We expect that concrete pavement may also be utilized in some areas of the project site. Typically, concrete pavement is used when heavy, repeated loads are expected in a specific area. Concrete pavement is commonly used for aprons, dumpster pads, truck turn-around, etc.



We recommend a minimum DGA thickness of eight inches beneath new concrete pavement and a minimum concrete thickness of five inches for new concrete pavement areas. Obviously, thicker pavement concrete sections can be used in select areas where heavy wheel loads are expected. We also recommend that the concrete pavement be reinforced with welded wire fabric or reinforcing steel. For dumpster pads and refuse container pads, the concrete pads should be large enough to accommodate both the refuse container and all axles of the truck.

16 NOTES ON THE REPORT AND RECOMMENDATIONS

While this report deals with samples of subsurface materials and some comments on water conditions at the site, no assessment of site environmental conditions or the presence of contaminants were performed.

This report is based on the provided project information, the subsurface conditions observed at the time of the report, and our experience with similar conditions. As such, it cannot be applied to other project sites, types, or combinations thereof. 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. Our recommendations may then require modification.

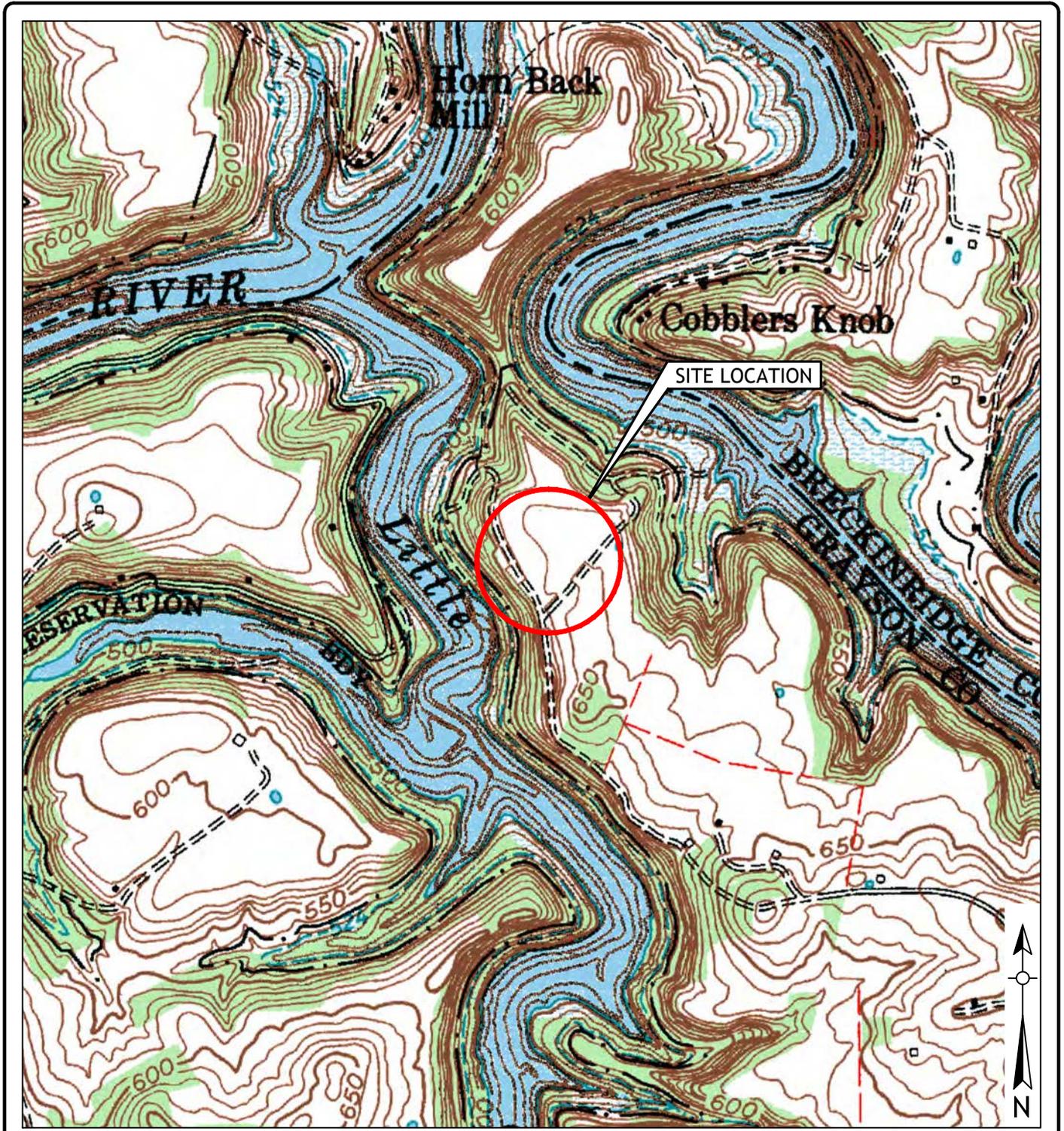
A geotechnical exploration, such as the one we performed, uses widely spaced borings to attempt to model the subsurface conditions at the site. Because no exploration contains complete data or a complete model, there is always a possibility that conditions between borings will be different from those at specific boring locations and that conditions will not be as anticipated by the project team. Also, it has been our experience that the construction process often disturbs soil conditions and this process, no matter how much experience we use to anticipate construction methodology, is not completely predictable. Therefore, changes or modifications to our recommendations are likely needed due to these possible variances. Experienced geotechnical personnel should be used to observe and document the construction procedures 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 CSI to provide this service based upon our familiarity with the project, the subsurface conditions and the intent of the recommendations.

No section or portion of this report (including appendix information) can be used as a stand alone article to make distinct changes or assumptions. The entire report and appendices should be used together as one resource. 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
Key to Symbols and Descriptions
Test Boring Records
Field Testing Procedures
Summary of Lab Testing Table(s) and Lab Testing Sheets
Laboratory Testing Procedures

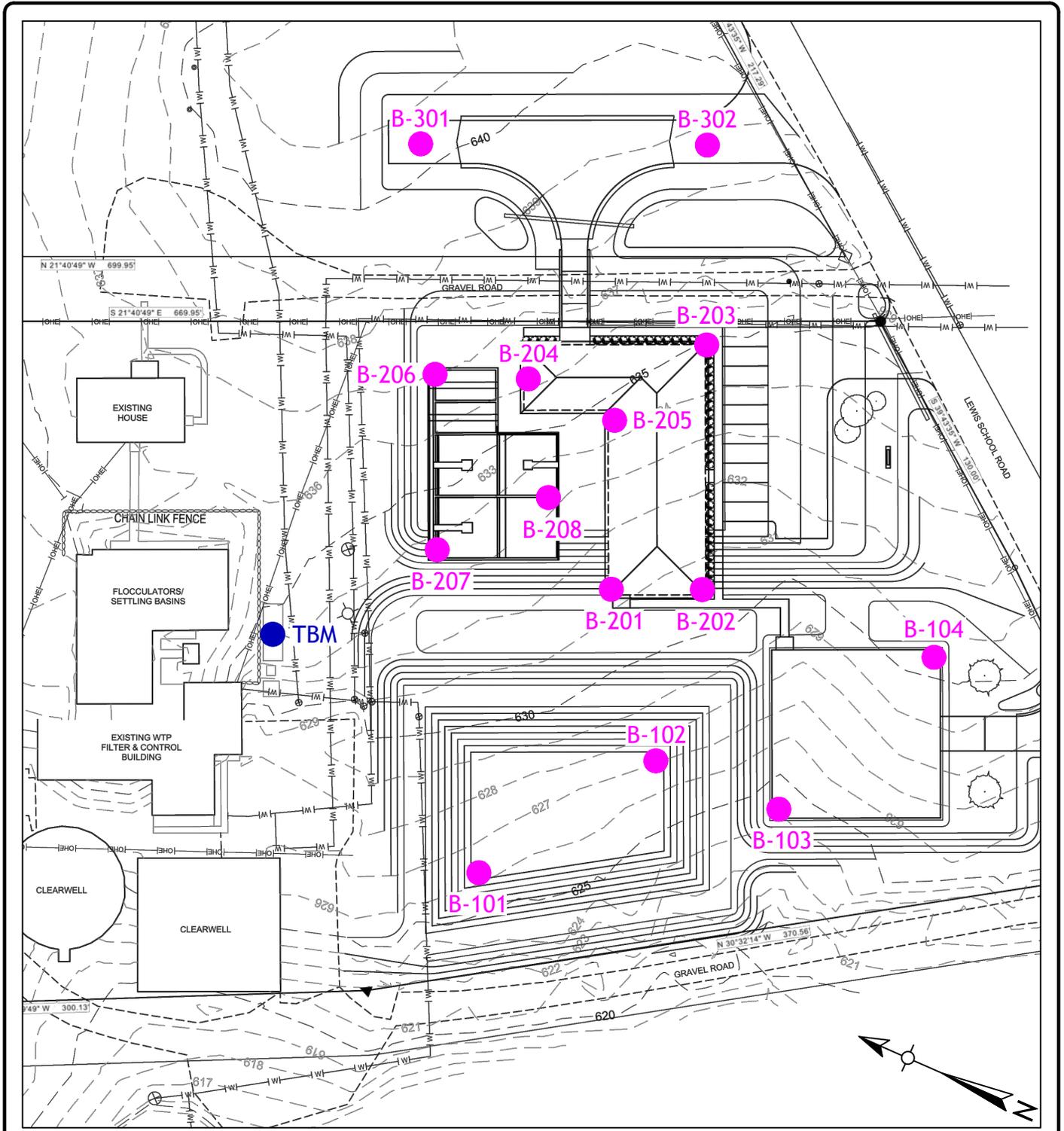


Site Location Plan adapted from USGS McDaniels Topographic Quadrangle map dated 1963 (photoinspected 1979), with further adaptation by CSI personnel.

FOR ILLUSTRATION PURPOSES ONLY

 Consulting Services Incorporated of Kentucky 11001 Bluegrass Parkway Ste. 325 Louisville, Kentucky, 40299 502.532.8267 Office 888.792.3121 Fax www.csikentucky.com	TITLE: SITE LOCATION PLAN	Project No: LV170016	Drawn By: JB
	PROJECT: LEITCHFIELD WATER TREATMENT PLANT EXPANSION LEITCHFIELD, KENTUCKY	Date: July 11, 2017	Checked By: WH
		Scale: Not To Scale	Drawing No: 1 of 1

This drawing is being furnished for this specific project only. Any party accepting this document does so in confidence and agrees that it shall not be duplicated in whole or in part, nor disclosed to others without the consent of Consulting Services Incorporated of Kentucky.



Boring Location Plan adapted from provided Proposed Site and Grading Plan dated October 24, 2016, with further adaptation by CSI personnel.
Elevations estimated using an assumed elevation located at TBM

LEGEND	
● B-XXX	BORING LOCATIONS
● TBM	TEMPORARY BENCHMARK

FOR ILLUSTRATION PURPOSES ONLY

 Consulting Services Incorporated of Kentucky 11001 Bluegrass Parkway Ste. 325 Louisville, Kentucky 40299 502.532.8267 Office 888.792.3121 Fax www.csikentucky.com	TITLE: BORING LOCATION PLAN	Project No: LV170016	Drawn By: JB
	PROJECT: LEITCHFIELD WATER TREATMENT PLANT EXPANSION LEITCHFIELD, KENTUCKY	Date: July 11, 2017	Checked By: WH
	Scale: Not To Scale	Drawing No: 1 of 1	

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Geotechnical Boring Information Sheet

Sample Type Symbols	Definitions
Splitspoon (SPT)  Shelby Tube  Grab  Rock Core  Auger Cuttings 	<p>SPT-"Splitspoon" or standard penetration test. Blow counts are number of drops required for a 140 lb hammer dropping 30 inches to drive the sampler 6 inches.</p> <p>N-value is the addition of the last two intervals of the 18-inch sample.</p> <p>Shelby tubes are often called "undisturbed samples". They are directly pushed into the ground, twisted, allowed to rest for a small period of time and then pulled out of the ground. Tops and bottoms are cleaned and then sealed.</p> <p>Sample classification is done in general accordance with ASTM D2487 and 2488 using the Unified Soil Classification System (USCS) as a general guide.</p>
Surface Symbols	
Topsoil  Asphalt  Concrete  Lean Clay  Fat Clay  Glacial Till  Sandy Clay  Silt  Elastic Silt  Lean Clay to Fat Clay  Gravelly Clay  Sandy Silt  Gravelly Silt  Sand  Gravel  Fill  Limestone  Sandstone  Shale/Siltstone  Weathered Rock 	<p>Soil moisture descriptions are based on the recovered sample observations. The descriptors are dry, slightly moist, moist, very moist and wet. These are typically based on relative estimates of the moisture condition of a visual estimation of the soils optimum moisture content (EOMC). Dry is almost in a "dusty" condition usually 6 or more percent below EOMC. Slightly moist is from about 6 to 2 percent below EOMC at a point at which the soil color does not readily change with the addition of water. Moist is usually 2 percent below to 2 percent above EOMC and the point at which the soil will tend to begin forming "balls" under some pressure in the hand. Very moist is usually from about 2 percent to 6 percent above EOMC and also the point at which it's often considered "muddy". Wet soil is usually 6 or more percent above EOMC and often contains free water or the soil is in a saturated state.</p> <p>Silt or Clay is defined at material finer than a standard #200 US sieve (<0.075mm) Sand is defined as material between the size of #200 sieve up to #4 sieve. Gravel is from #4 size sieve material to 3". Cobbles are from 3" to 12". Boulders are over 12".</p> <p>Rock hardness is classified as follows: Very Soft: Easily broken by hand pressure Soft: Ends can be broken by hand pressure; easily broken with hammer Medium: Ends easily broken with hammer; middle requires moderate blow Hard: Ends require moderate hammer blow; middle requires several blows Very Hard: Many blows with a hammer required to break core</p> <p>Rock Quality Designation (RQD) is defined as total combined length of 4" or longer pieces of core divided by the total core run length; defined in percentage.</p>
Samples Strength Descriptors	
Cohesive Soils: Very Soft N 0-1 Soft 2-4 Firm 5-8 Stiff 9-15 Very Stiff 16-30 Hard 31+ Non-cohesive Soils: Very Loose 0-4 Loose 5-10 Firm 11-20 Very Firm 21-30 Dense 30-50 Very Dense 51+	<p>Water or cave-in observed in borings is at completion of drilling each boring unless otherwise noted.</p> <p>Strata lengths shown on borings represents a rough estimate. Transition may be more abrupt or gradual. Soil borings are representative of that estimated location at that time and are based on recovered samples. Conditions may be different between borings and between sample intervals. Boring information is not to be considered stand alone but should be taken in context with comments and information in the geotechnical report and the means by which the borings are logged, sampled and drilled.</p>

BORING LOG

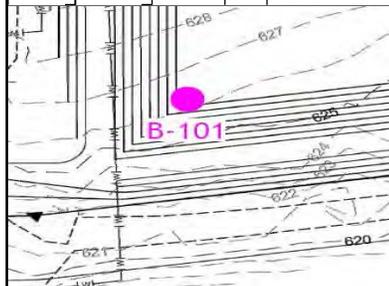
Consulting Services Incorporated
 11001 Bluegrass Parkway Ste. 325
 Louisville, Kentucky 40299
 Phone: 502.532.8267
 Fax: 888.792.3121



BORING: B-101

Project Number: LV170016 Name: Leithfield Water Treatment Plant Expansion Client: Cann-Tech, LLC Location: Leitchfield, Kentucky Logged By: W. Harmon	Weather: Sunny, 70's Elevation (ft): 91.0 Date Started: 6/26/17 Date Completed: 6/26/17 Checked By: A. Nelson, PE	Contractor: CSI Drilling Drill Rig: CME 550 Method: SFA Hole Size (in): 4
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Elev. (ft)	Depth (ft)	Symbol	Description	Blow Counts (N Value)	Recov. (in)	Water Level	Remarks
90			TOPSOIL - 9 inches	2-2-50/4"	16		Dry upon completion of soil augering
	2	CL	LEAN CLAY (CL) - SOFT, dark brown, sandy, moist				
			Auger Refusal at 1.9 feet				
88							
	4						
86							
	6						
84							
	8						
82							
	10						
80							
	12						
78							
	14						
76							
	16						
74							
	18						
72							
	20						
70							
	22						
68							
	24						
66							
	26						
64							
	28						
62							
	30						
60							



*
 Left Photo: Photo of Approximate Boring Location
 Right Photo: Photo of Boring

BORING LOG

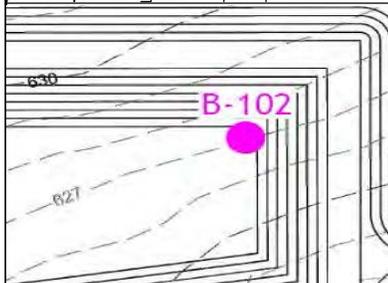
Consulting Services Incorporated
 11001 Bluegrass Parkway Ste. 325
 Louisville, Kentucky 40299
 Phone: 502.532.8267
 Fax: 888.792.3121



BORING: B-102

Project Number: LV170016 Name: Leithfield Water Treatment Plant Expansion Client: Cann-Tech, LLC Location: Leitchfield, Kentucky Logged By: W. Harmon	Weather: Sunny, 70's Elevation (ft): 92.3 Date Started: 6/26/17 Date Completed: 6/26/17 Checked By: A. Nelson, PE	Contractor: CSI Drilling Drill Rig: CME 550 Method: SFA Hole Size (in): 4
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Elev. (ft)	Depth (ft)	Symbol	Description	Blow Counts (N Value)	Recov. (in)	Water Level	Remarks
92			TOPSOIL - 8 inches	1-2-50/4"	16		Dry upon completion of soil excavation
90	2	CL	LEAN CLAY (CL) - SOFT, light brown, with red and gray mottling, with sandstone fragments, moist				
88	4		Auger Refusal at 3.8 feet				
86	6						
84	8						
82	10						
80	12						
78	14						
76	16						
74	18						
72	20						
70	22						
68	24						
66	26						
64	28						
62	30						



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 Left Photo: Photo of Approximate Boring Location
 Right Photo: Photo of Boring

BORING LOG

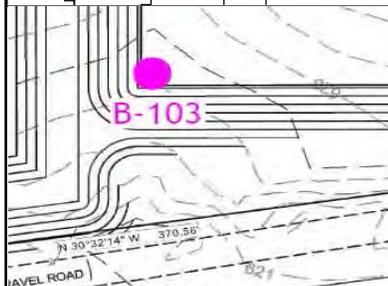
Consulting Services Incorporated
 11001 Bluegrass Parkway Ste. 325
 Louisville, Kentucky 40299
 Phone: 502.532.8267
 Fax: 888.792.3121



BORING: B-103

Project Number: LV170016 Name: Leithfield Water Treatment Plant Expansion Client: Cann-Tech, LLC Location: Leitchfield, Kentucky Logged By: W. Harmon	Weather: Sunny, 70's Elevation (ft): 90.4 Date Started: 6/27/17 Date Completed: 6/27/17 Checked By: A. Nelson, PE	Contractor: CSI Drilling Drill Rig: CME 550 Method: SFA Hole Size (in): 4
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Elev. (ft)	Depth (ft)	Symbol	Description	Blow Counts (N Value)	Recov. (in)	Water Level	Remarks
90	0		TOPSOIL - 8 inches				Dry upon completion of soil augering
	2	CL	LEAN CLAY (CL) - HARD, medium brown, with sand (increasing with depth), moist	1-2-50/4" 34-50/1"	16 7		
88		CL	LEAN CLAY (CL) - HARD, light gray to red, sandy, moist				
86	4		Auger Refusal at 3.8 feet Begin Coring at 3.8 feet				
84	6		SANDSTONE - light yellowish-gray to light olive-gray, very fine to medium grained		60		
82	8		Coring Terminated at 8.8 feet				No core water loss observed REC (%) - 100 RQD (%) - 33
80	10						
78	12						
76	14						
74	16						
72	18						
70	20						
68	22						
66	24						
64	26						



*
 Left Photo: Photo of Approximate Boring Location
 Right Photo: Photo of Boring

BORING LOG

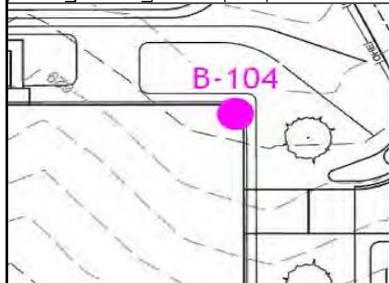
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 Louisville, Kentucky 40299
 Phone: 502.532.8267
 Fax: 888.792.3121



BORING: B-104

Project Number: LV170016 Name: Leithfield Water Treatment Plant Expansion Client: Cann-Tech, LLC Location: Leitchfield, Kentucky Logged By: W. Harmon	Weather: Sunny, 70's Elevation (ft): 95.5 Date Started: 6/27/17 Date Completed: 6/27/17 Checked By: A. Nelson, PE	Contractor: CSI Drilling Drill Rig: CME 550 Method: SFA Hole Size (in): 4
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Elev. (ft)	Depth (ft)	Symbol	Description	Blow Counts (N Value)	Recov. (in)	Water Level	Remarks
94	0		TOPSOIL - 9 inches	1-2-4 (6)	18		Dry upon completion of soil augering
94	2	CL	LEAN CLAY (CL) - FIRM, light brown, moist	6-10-11 (21)	18		
92	4	CL	LEAN CLAY (CL) - VERY STIFF, light brown to brown, with gray mottling, with sand (increasing with depth), with rock fragments below 4', moist	10-50/3"	8		
90	6		Auger Refusal at 6.0 feet				
88	8						
86	10						
84	12						
82	14						
80	16						
78	18						
76	20						
74	22						
72	24						
70	26						
68	28						
66	30						
64							



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 Left Photo: Photo of Approximate Boring Location
 Right Photo: Photo of Boring

BORING LOG

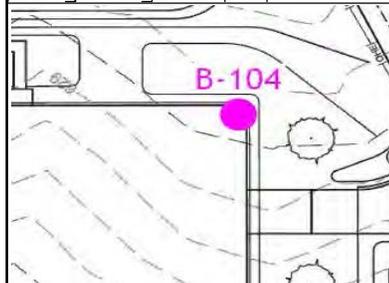
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 Louisville, Kentucky 40299
 Phone: 502.532.8267
 Fax: 888.792.3121



BORING: B-104A

Project Number: LV170016 Name: Leithfield Water Treatment Plant Expansion Client: Cann-Tech, LLC Location: Leitchfield, Kentucky Logged By: W. Harmon	Weather: Sunny, 70's Elevation (ft): 95.5 Date Started: 6/27/17 Date Completed: 6/27/17 Checked By: A. Nelson, PE	Contractor: CSI Drilling Drill Rig: CME 550 Method: SFA Hole Size (in): 4
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Elev. (ft)	Depth (ft)	Symbol	Description	Blow Counts (N Value)	Recov. (in)	Water Level	Remarks
94	2		Offset from B-104 to obtain a relatively undisturbed sample Shelby Tube		24		Dry upon completion of soil augering Qu = 6.3 ksf
92	4		Boring Terminated at 3.5 feet				
90	6						
88	8						
86	10						
84	12						
82	14						
80	16						
78	18						
76	20						
74	22						
72	24						
70	26						
68	28						
66	30						
64							



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Left Photo: Photo of Approximate Boring Location
 Right Photo: Photo of Boring

BORING LOG

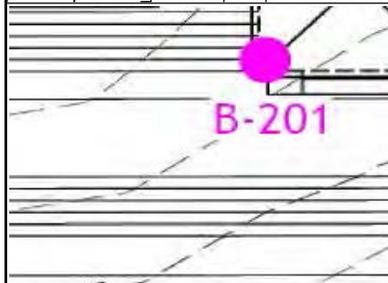
Consulting Services Incorporated
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 Louisville, Kentucky 40299
 Phone: 502.532.8267
 Fax: 888.792.3121



BORING: B-201

Project Number: LV170016 Name: Leithfield Water Treatment Plant Expansion Client: Cann-Tech, LLC Location: Leitchfield, Kentucky Logged By: W. Harmon	Weather: Sunny, 70's Elevation (ft): 95.9 Date Started: 6/26/17 Date Completed: 6/26/17 Checked By: A. Nelson, PE	Contractor: CSI Drilling Drill Rig: CME 550 Method: SFA Hole Size (in): 4
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Elev. (ft)	Depth (ft)	Symbol	Description	Blow Counts (N Value)	Recov. (in)	Water Level	Remarks
			TOPSOIL - 10 inches	2-2-3 (5)	14		Dry upon completion of soil augering
94	2	CL	LEAN CLAY (CL) - FIRM, reddish-brown, moist	4-10-15 (25)	18		
92	4	CL	LEAN CLAY (CL) - VERY STIFF, reddish-brown, with gray mottling, moist				
90	6	CL	LEAN CLAY (CL) - VERY STIFF, reddish-brown, with sand, moist	5-9-50/5"	17		
88	8		Auger Refusal at 6.0 feet Begin Coring at 6.0 feet				No core water loss observed REC (%) - 98 RQD (%) - 54
86	10		SANDSTONE - light yellowish-gray to light olive-gray, very fine to medium grained		118		
84	12						
82	14						
80	16		SANDSTONE - light olive-gray to light yellowish-brown, very fine to medium grained				REC (%) - 100 RQD (%) - 63
78	18						
76	20				120		
74	22						
72	24						
70	26		Coring Terminated at 26.0 feet				
68	28						
66	30						



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 Left Photo: Photo of Approximate Boring Location
 Right Photo: Photo of Boring

BORING LOG

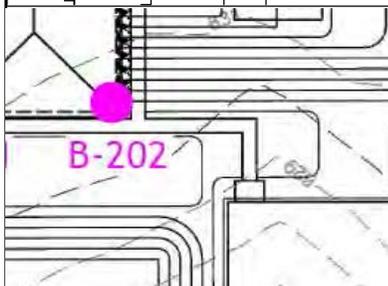
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 Fax: 888.792.3121



BORING: B-202

Project Number: LV170016 Name: Leithfield Water Treatment Plant Expansion Client: Cann-Tech, LLC Location: Leitchfield, Kentucky Logged By: W. Harmon	Weather: Sunny, 70's Elevation (ft): 95.9 Date Started: 6/26/17 Date Completed: 6/26/17 Checked By: A. Nelson, PE	Contractor: CSI Drilling Drill Rig: CME 550 Method: SFA Hole Size (in): 4
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Elev. (ft)	Depth (ft)	Symbol	Description	Blow Counts (N Value)	Recov. (in)	Water Level	Remarks
			TOPSOIL - 8 inches	1-1-2 (3)	18		Dry upon completion of soil augering
94	2	CL	LEAN CLAY (CL) - SOFT, brown, moist	3-7-11 (18)	18		
92	4	CL	LEAN CLAY (CL) - VERY STIFF, light brown, with gray mottling, with sand, with rock fragments, with varying amounts of black oxide nodules, moist	10-50/2"	8		
90	6		Auger Refusal at 5.0 feet				
88	8						
86	10						
84	12						
82	14						
80	16						
78	18						
76	20						
74	22						
72	24						
70	26						
68	28						
66	30						



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 Left Photo: Photo of Approximate Boring Location
 Right Photo: Photo of Boring

BORING LOG

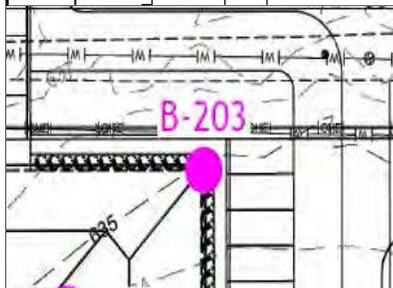
Consulting Services Incorporated
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 Louisville, Kentucky 40299
 Phone: 502.532.8267
 Fax: 888.792.3121



BORING: B-203

Project Number: LV170016 Name: Leithfield Water Treatment Plant Expansion Client: Cann-Tech, LLC Location: Leitchfield, Kentucky Logged By: W. Harmon	Weather: Sunny, 70's Elevation (ft): 99.6 Date Started: 6/26/17 Date Completed: 6/26/17 Checked By: A. Nelson, PE	Contractor: CSI Drilling Drill Rig: CME 550 Method: SFA Hole Size (in): 4
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Elev. (ft)	Depth (ft)	Symbol	Description	Blow Counts (N Value)	Recov. (in)	Water Level	Remarks
98	2	CL	TOPSOIL - 8 inches LEAN CLAY (CL) - SOFT to FIRM, reddish-brown and gray, moist	1-2-2 (4) 3-3-4 (7)	16 18		Dry upon completion of soil augering
96	4	CL	LEAN CLAY (CL) - STIFF, light brown, with olive-gray mottling, with sand, moist	4-6-7 (13)	18		
94	6	CL	LEAN CLAY (CL) - STIFF, reddish-brown, with gray mottling, moist	4-6-7 (13)	18		
92	8	CL	Auger Refusal at 9.7 feet				
90	10						
88	12						
86	14						
84	16						
82	18						
80	20						
78	22						
76	24						
74	26						
72	28						
70	30						
68							



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 Left Photo: Photo of Approximate Boring Location
 Right Photo: Photo of Boring

BORING LOG

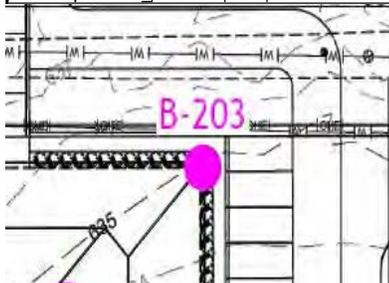
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BORING: B-203A

Project Number: LV170016 Name: Leithfield Water Treatment Plant Expansion Client: Cann-Tech, LLC Location: Leitchfield, Kentucky Logged By: W. Harmon	Weather: Sunny, 70's Elevation (ft): 99.6 Date Started: 6/26/17 Date Completed: 6/26/17 Checked By: A. Nelson, PE	Contractor: CSI Drilling Drill Rig: CME 550 Method: SFA Hole Size (in): 4
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Elev. (ft)	Depth (ft)	Symbol	Description	Blow Counts (N Value)	Recov. (in)	Water Level	Remarks
98	2		Offset from B-203 to obtain a relatively undisturbed sample				Dry upon completion of soil augering
96	4						
94	6		Shelby Tube		24		
92	8		Boring Terminated at 7.0 feet				
90	10						
88	12						
86	14						
84	16						
82	18						
80	20						
78	22						
76	24						
74	26						
72	28						
70	30						
68							



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Left Photo: Photo of Approximate Boring Location
 Right Photo: Photo of Boring

BORING LOG

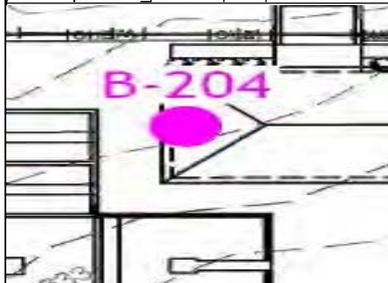
Consulting Services Incorporated
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 Louisville, Kentucky 40299
 Phone: 502.532.8267
 Fax: 888.792.3121



BORING: B-204

Project Number: LV170016 Name: Leithfield Water Treatment Plant Expansion Client: Cann-Tech, LLC Location: Leitchfield, Kentucky Logged By: W. Harmon	Weather: Sunny, 70's Elevation (ft): 100.9 Date Started: 6/26/17 Date Completed: 6/26/17 Checked By: A. Nelson, PE	Contractor: CSI Drilling Drill Rig: CME 550 Method: SFA Hole Size (in): 4
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Elev. (ft)	Depth (ft)	Symbol	Description	Blow Counts (N Value)	Recov. (in)	Water Level	Remarks
100	0		TOPSOIL - 6 inches	2-1-2 (3)	16		Dry upon completion of soil augering
	2	CL	LEAN CLAY (CL) - SOFT, reddish-brown, moist	3-4-10 (14)	18		
98	4	CL	LEAN CLAY (CL) - STIFF, light reddish-brown, with gray mottling, moist	4-9-10 (19)	18		
96	6		LEAN CLAY (CL) - VERY STIFF to STIFF, light reddish-brown, with gray mottling, with black oxide nodules, moist	4-5-7 (12)	3		
94	8	CL		50/3"	2		
92	10		Auger Refusal at 10.0 feet				
90	12						
88	14						
86	16						
84	18						
82	20						
80	22						
78	24						
76	26						
74	28						
72	30						
70							



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 Left Photo: Photo of Approximate Boring Location
 Right Photo: Photo of Boring

BORING LOG

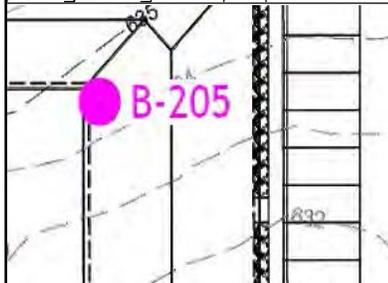
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BORING: B-205

Project Number: LV170016 Name: Leithfield Water Treatment Plant Expansion Client: Cann-Tech, LLC Location: Leitchfield, Kentucky Logged By: W. Harmon	Weather: Sunny, 70's Elevation (ft): 99.0 Date Started: 6/26/17 Date Completed: 6/26/17 Checked By: A. Nelson, PE	Contractor: CSI Drilling Drill Rig: CME 550 Method: SFA Hole Size (in): 4
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Elev. (ft)	Depth (ft)	Symbol	Description	Blow Counts (N Value)	Recov. (in)	Water Level	Remarks
98	0	CL	TOPSOIL - 7 inches	2-2-3 (5)	16		Dry upon completion of soil augering
96	2	CL	LEAN CLAY (CL) - FIRM, reddish-brown, moist	2-5-11 (16)	17		
94	4	CL	LEAN CLAY (CL) - VERY STIFF, reddish-brown, with gray mottling, moist	9-9-11 (20)	18		
92	6	CL	LEAN CLAY (CL) - VERY STIFF, olive-gray, with red oxide staining, moist	5-16-50/1"	11		
90	8		Auger Refusal at 9.0 feet				
88	10						
86	12						
84	14						
82	16						
80	18						
78	20						
76	22						
74	24						
72	26						
70	28						
68	30						



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 Left Photo: Photo of Approximate Boring Location
 Right Photo: Photo of Boring

BORING LOG

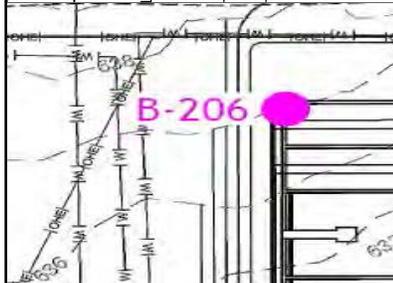
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 Louisville, Kentucky 40299
 Phone: 502.532.8267
 Fax: 888.792.3121



BORING: B-206

Project Number: LV170016 Name: Leithfield Water Treatment Plant Expansion Client: Cann-Tech, LLC Location: Leitchfield, Kentucky Logged By: W. Harmon	Weather: Sunny, 70's Elevation (ft): 101.1 Date Started: 6/27/17 Date Completed: 6/27/17 Checked By: A. Nelson, PE	Contractor: CSI Drilling Drill Rig: CME 550 Method: SFA Hole Size (in): 4
---	--	--

Elev. (ft)	Depth (ft)	Symbol	Description	Blow Counts (N Value)	Recov. (in)	Water Level	Remarks
100	0		TOPSOIL - 8 inches	2-1-1 (2)	15		Dry upon completion of soil augering
98	2	CL	LEAN CLAY (CL) - SOFT to STIFF, brown to light brown, with gray mottling, moist	4-6-8 (14)	17		
96	4		LEAN CLAY (CL) - STIFF to VERY STIFF, reddish-brown to olive-gray, moist	5-6-8 (14)	15		
94	6	CL		5-7-10 (17)	18		
92	8	CL	LEAN CLAY (CL) - VERY STIFF, light reddish-brown, with sand, moist	50/3"	2		
90	10		Auger Refusal at 9.8 feet				
88	12						
86	14						
84	16						
82	18						
80	20						
78	22						
76	24						
74	26						
72	28						
70	30						



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 Left Photo: Photo of Approximate Boring Location
 Right Photo: Photo of Boring

BORING LOG

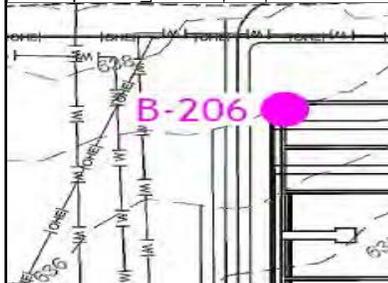
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 Louisville, Kentucky 40299
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 Fax: 888.792.3121



BORING: B-206A

Project Number: LV170016 Name: Leithfield Water Treatment Plant Expansion Client: Cann-Tech, LLC Location: Leitchfield, Kentucky Logged By: W. Harmon	Weather: Sunny, 70's Elevation (ft): 101.1 Date Started: 6/27/17 Date Completed: 6/27/17 Checked By: A. Nelson, PE	Contractor: CSI Drilling Drill Rig: CME 550 Method: SFA Hole Size (in): 4
---	--	--

Elev. (ft)	Depth (ft)	Symbol	Description	Blow Counts (N Value)	Recov. (in)	Water Level	Remarks
100	2		Offset from B-206 to obtain a relatively undisturbed sample				Dry upon completion of soil augering
98	4						
96	6		Shelby Tube		24		Qu = 2.7 ksf
94	8		Boring Terminated at 8.0 feet				
92	10						
90	12						
88	14						
86	16						
84	18						
82	20						
80	22						
78	24						
76	26						
74	28						
72	30						
70							



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 Left Photo: Photo of Approximate Boring Location
 Right Photo: Photo of Boring

BORING LOG

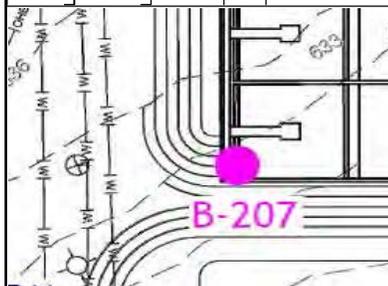
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 Fax: 888.792.3121



BORING: B-207

Project Number: LV170016 Name: Leithfield Water Treatment Plant Expansion Client: Cann-Tech, LLC Location: Leitchfield, Kentucky Logged By: W. Harmon	Weather: Sunny, 70's Elevation (ft): 98.5 Date Started: 6/27/17 Date Completed: 6/27/17 Checked By: A. Nelson, PE	Contractor: CSI Drilling Drill Rig: CME 550 Method: SFA Hole Size (in): 4
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Elev. (ft)	Depth (ft)	Symbol	Description	Blow Counts (N Value)	Recov. (in)	Water Level	Remarks
98	0		TOPSOIL - 9 inches	1-3-3 (6)	18		Dry upon completion of soil augering
96	2	CL	LEAN CLAY (CL) - FIRM to VERY STIFF, light brown, with gray mottling, with some red oxide staining, with sand, moist	4-8-9 (17)	18		
94	4			5-7-9 (16)	16		
92	6			50/4"	4		
90	8	CL	LEAN CLAY (CL) - VERY STIFF, bluish-olive gray, with red oxide staining, with sand, moist Auger Refusal at 7.3 feet				
88	10						
86	12						
84	14						
82	16						
80	18						
78	20						
76	22						
74	24						
72	26						
70	28						
68	30						



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 Left Photo: Photo of Approximate Boring Location
 Right Photo: Photo of Boring

BORING LOG

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 Fax: 888.792.3121



BORING: B-208

Project Number: LV170016 Name: Leithfield Water Treatment Plant Expansion Client: Cann-Tech, LLC Location: Leitchfield, Kentucky Logged By: W. Harmon	Weather: Sunny, 70's Elevation (ft): 98.1 Date Started: 6/26/17 Date Completed: 6/26/17 Checked By: A. Nelson, PE	Contractor: CSI Drilling Drill Rig: CME 550 Method: SFA Hole Size (in): 4
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Elev. (ft)	Depth (ft)	Symbol	Description	Blow Counts (N Value)	Recov. (in)	Water Level	Remarks
96	2		TOPSOIL - 6 inches	1-3-6 (9)	18		Dry upon completion of soil augering
94	4	CL	LEAN CLAY (CL) - STIFF to VERY STIFF, light reddish-brown, with gray mottling, moist	4-10-13 (23)	12		
92	6			8-10-12 (22)	18		
90	8	CL	LEAN CLAY (CL) - VERY STIFF, olive-gray and reddish-brown, with some sand, moist	6-50/2"	8		
88	10		Auger Refusal at 8.1 feet Begin Coring at 8.1 feet				
86	12		SANDSTONE - light yellowish-gray to light olive-gray, very fine to medium grained		58		No core water loss observed REC (%) - 97 RQD (%) - 43
84	14		Coring Terminated at 13.1 feet				
82	16						
80	18						
78	20						
76	22						
74	24						
72	26						
70	28						
68	30						



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Left Photo: Photo of Approximate Boring Location
 Right Photo: Photo of Boring

BORING LOG

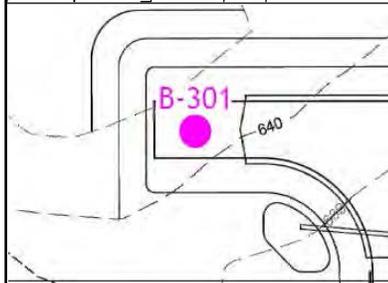
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 Louisville, Kentucky 40299
 Phone: 502.532.8267
 Fax: 888.792.3121



BORING: B-301

Project Number: LV170016 Name: Leithfield Water Treatment Plant Expansion Client: Cann-Tech, LLC Location: Leitchfield, Kentucky Logged By: W. Harmon	Weather: Sunny, 70's Elevation (ft): 105.6 Date Started: 6/26/17 Date Completed: 6/26/17 Checked By: A. Nelson, PE	Contractor: CSI Drilling Drill Rig: CME 550 Method: SFA Hole Size (in): 4
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Elev. (ft)	Depth (ft)	Symbol	Description	Blow Counts (N Value)	Recov. (in)	Water Level	Remarks
104	2	CL	TOPSOIL - 8 inches LEAN CLAY (CL) - SOFT, medium to dark reddish-brown, moist	1-2-2 (4)	16		Dry upon completion of soil augering
102	4	CH	FAT CLAY (CH) - STIFF to VERY STIFF, reddish-brown, with gray mottling, with sand, moist	4-5-8 (13)	15		
100	6		Boring Terminated at 5.5 feet	4-8-13 (21)	17		
98	8						
96	10						
94	12						
92	14						
90	16						
88	18						
86	20						
84	22						
82	24						
80	26						
78	28						
76	30						
74							



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 Left Photo: Photo of Approximate Boring Location
 Right Photo: Photo of Boring

BORING LOG

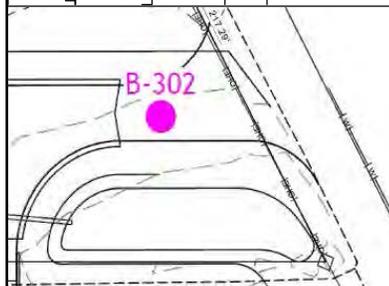
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BORING: B-302

Project Number: LV170016 Name: Leithfield Water Treatment Plant Expansion Client: Cann-Tech, LLC Location: Leitchfield, Kentucky Logged By: W. Harmon	Weather: Sunny, 70's Elevation (ft): 103.9 Date Started: 6/26/17 Date Completed: 6/26/17 Checked By: A. Nelson, PE	Contractor: CSI Drilling Drill Rig: CME 550 Method: SFA Hole Size (in): 4
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Elev. (ft)	Depth (ft)	Symbol	Description	Blow Counts (N Value)	Recov. (in)	Water Level	Remarks
			TOPSOIL - 12 inches	1-2-2 (4)	16		Dry upon completion of soil augering
102	2	CL	LEAN CLAY (CL) - SOFT, brown, moist	2-4-5 (9)	18		
100	4	CL	LEAN CLAY (CL) - STIFF, light reddish-brown, with gray mottling, moist	5-7-8 (15)	18		
98	6		Boring Terminated at 5.5 feet				
96	8						
94	10						
92	12						
90	14						
88	16						
86	18						
84	20						
82	22						
80	24						
78	26						
76	28						
74	30						



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 Left Photo: Photo of Approximate Boring Location
 Right Photo: Photo of Boring

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FIELD TESTING PROCEDURES

Field Operations: The general field procedures employed by CSI are summarized in ASTM D 420 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 and in situ methods as well as borings.

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

- 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 the chief driller. 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 D 2488 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 D 1586.

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.

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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 D 2113 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".

Hand Auger Borings and Dynamic Cone Penetration Testing: Hand auger borings are performed manually by CSI field personnel. This consists of manually twisting hand auger tools into the subsurface and extracting "grab" or baggie samples at intervals determined by the project engineer. At the sample intervals, dynamic cone penetration (DCP) testing is performed. This testing involves the manual raising and dropping of a 20-pound hammer, 18 inches. This "driver" head drives a solid-13/4 inch diameter cone into the ground. DCP "counts" are the number of drops it takes for the hammer to drive three 13/4 inch increments, recorded as X-Y-Z values.

Test Pits: Test pits are excavated by the equipment available, often a backhoe or trackhoe. The dimensions of the test pits are based on the equipment used and the power capacity of the equipment. Samples are taken from the spoils of typical buckets of the excavator and sealed in jars or "Ziploc" baggies. Dynamic Cone Penetration or hand probe testing is often performed in the upper few feet as OSHA standards allow. Refusal is deemed as the lack of advancement of the equipment with reasonable to full machine effort.

Water Level Readings: Water table readings are normally taken in conjunction with borings and are recorded on the "Test Boring Records". 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.

Summary of Laboratory Results

Borehole	Depth	Sample Type	Liquid Limit	Plastic Limit	Plasticity Index	Classification	Water Content (%)	Unconfined Compressive Strength (ksf)	Dry Density (pcf)	Wet Density (pcf)	Max. Dry Density (pcf)	Opt. Water Content (%)	CBR	Swell (%)	RQD	Percent Recovery	k (cm/sec)	% Finer #200
B102	0.0	SS					22.5											
B104	0.0	SS					25.9											
B104	4.0	SS					24.3											74
B104	1.5	ST	32	21	11	CL	22.7	6.3										
B201	0.0	SS					27.0											
B201	4.0	SS					20.4											
B201	17.0	CORE						578.90										
B202	1.5	SS					18.0											
B202	4.0	SS					21.3											
B203	0.0	SS					26.9											
B203	1.5	SS					21.5											
B203	4.0	SS					21.9											
B203	5.0	ST	43	17	26	CL	22.2	2.9										81
B204	1.5	SS					21.2											
B204	4.0	SS					17.7											
B204	6.5	SS					21.5											
B205	1.5	SS					19.6											
B205	4.0	SS					23.2											
B205	6.5	SS					19.4											
B206	1.5	SS					16.5											
B206	4.0	SS					25.8											
B206	6.0	ST					23.2	2.7										
B207	1.5	SS					15.7											
B207	4.0	SS					27.6											
B208	0.0	SS					24.8											
B208	4.0	SS					22.7											

 <p>Consulting Services Incorporated of Kentucky 11001 Bluegrass Parkway Ste. 325 Louisville, Kentucky 40299 502.532.8267 Office 888.792.3121 Fax www.csikentucky.com</p>	<p>SS - Split Spoon Sample GRAB - Bulk Grab Sample k - Coefficient of Permeability - See Attached test Results</p>	<p style="text-align: center;">PROJECT INFORMATION</p> <p>Client: Cann-Tech, LLC Project Name: Leitchfield Water Treatment Plant Expansion Project Number: LV170016 Project Location: Leitchfield, Kentucky</p>
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Summary of Laboratory Results

Borehole	Depth	Sample Type	Liquid Limit	Plastic Limit	Plasticity Index	Classification	Water Content (%)	Unconfined Compressive Strength (ksf)	Dry Density (pcf)	Wet Density (pcf)	Max. Dry Density (pcf)	Opt. Water Content (%)	CBR	Swell (%)	RQD	Percent Recovery	k (cm/sec)	% Finer #200
B208	6.5	SS					19.6											
B301	1.5	SS					28.4											
B301	4.0	SS	68	24	44	CH	26.0											77
B302	1.5	SS					24.1											
B302	4.0	SS					29.8											
B204-205	4.0	GRAB	41	16	25	CL	21.4				106.8	18.6						85



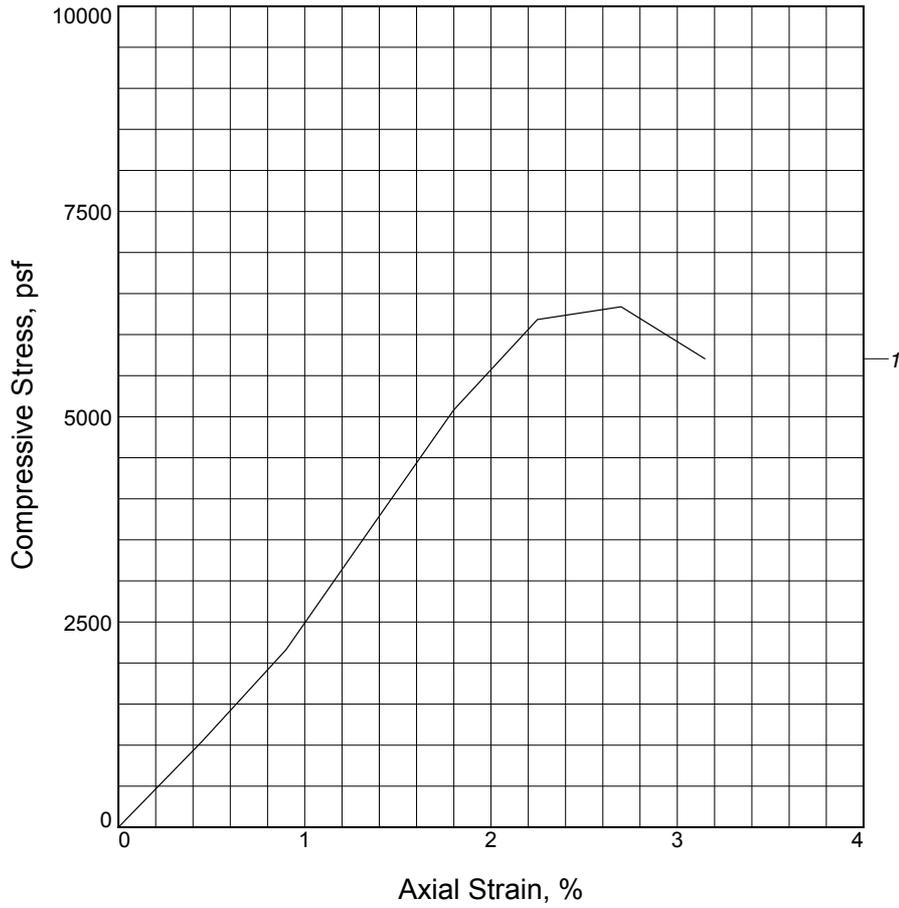
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 502.532.8267 Office | 888.792.3121 Fax
www.csikentucky.com

SS - Split Spoon Sample
 GRAB - Bulk Grab Sample
 k - Coefficient of Permeability
 - See Attached test Results

PROJECT INFORMATION

Client: Cann-Tech, LLC
 Project Name: **Leitchfield Water Treatment Plant**
 Expansion Project Number: LV170016
 Project Location: Leitchfield, Kentucky

UNCONFINED COMPRESSION TEST



Sample No.	1		
Unconfined strength, psf	6339		
Undrained shear strength, psf	3170		
Failure strain, %	2.7		
Strain rate, in./min.	0.94		
Water content, %	16.6		
Wet density, pcf	136.5		
Dry density, pcf	117.0		
Saturation, %	100.0		
Void ratio	0.4407		
Specimen diameter, in.	2.87		
Specimen height, in.	5.56		
Height/diameter ratio	1.93		

Description: brown LEAN CLAY with SAND (CL)

LL = 32 **PL = 21** **PI = 11** **Assumed GS= 2.70** **Type:**

Project No.: LV170016

Date Sampled:

Remarks:

Client: Cann-Tech, LLC

Project: Leitchfield Water Treatment Plant Expansion

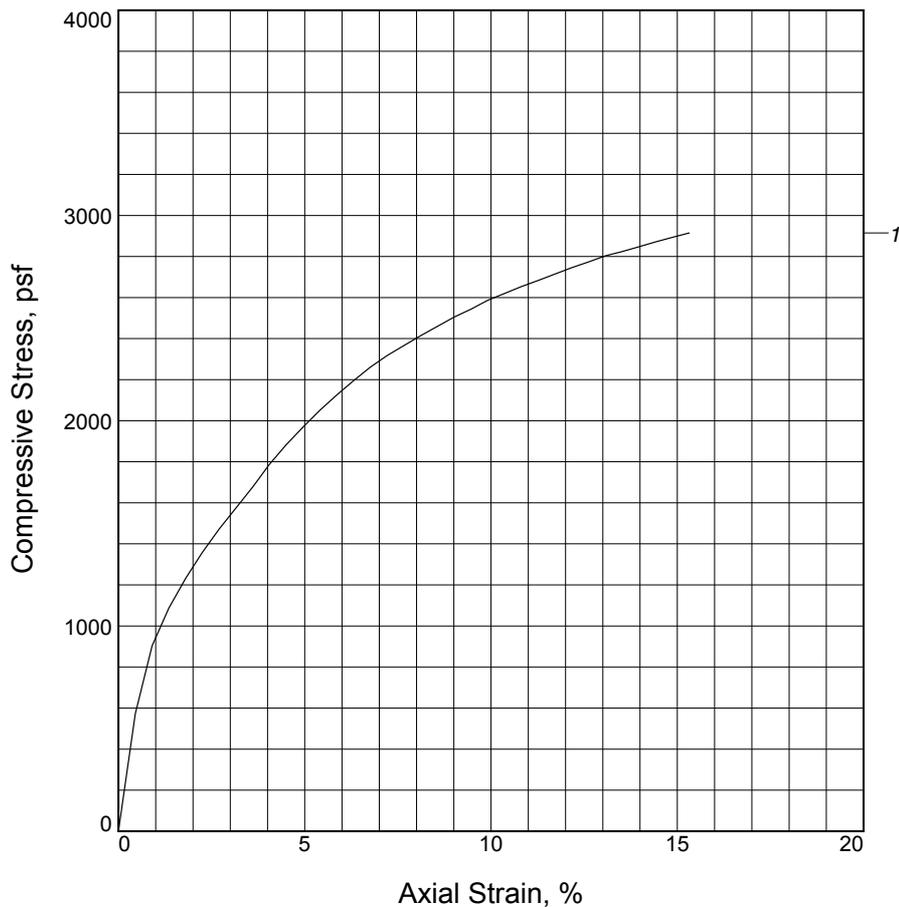
Sample Number: B104 **Depth:** 1.5'

Figure 1



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UNCONFINED COMPRESSION TEST



Sample No.	1		
Unconfined strength, psf	2915		
Undrained shear strength, psf	1457		
Failure strain, %	15.3		
Strain rate, in./min.	0.94		
Water content, %	23.2		
Wet density, pcf	131.1		
Dry density, pcf	106.4		
Saturation, %	100.0		
Void ratio	0.5835		
Specimen diameter, in.	2.75		
Specimen height, in.	5.55		
Height/diameter ratio	2.01		

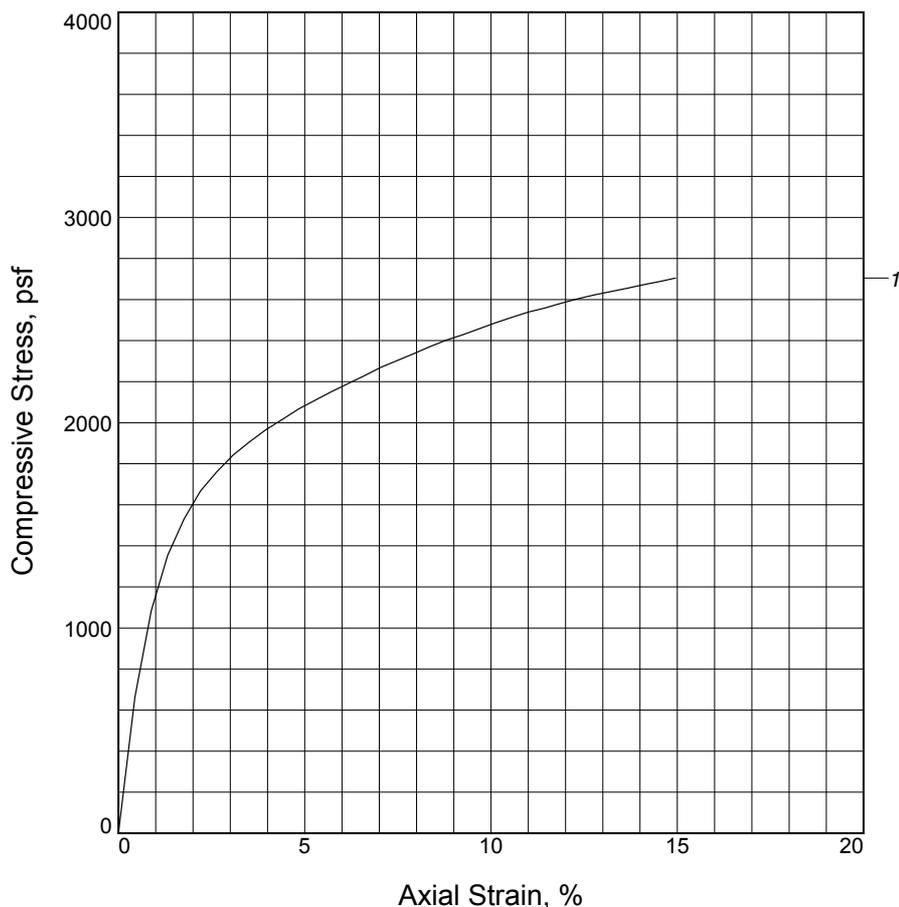
Description: brown LEAN CLAY with SAND (CL)

LL = 43 **PL = 17** **PI = 26** **Assumed GS= 2.7** **Type:**

<p>Project No.: LV170016</p> <p>Date Sampled:</p> <p>Remarks:</p>	<p>Client: Cann-Tech, LLC</p> <p>Project: Leitchfield Water Treatment Plant Expansion</p> <p>Sample Number: B203 Depth: 5.0'</p>
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Figure 1

UNCONFINED COMPRESSION TEST



Sample No.	1		
Unconfined strength, psf	2705		
Undrained shear strength, psf	1352		
Failure strain, %	15.0		
Strain rate, in./min.	0.94		
Water content, %	22.6		
Wet density, pcf	125.2		
Dry density, pcf	102.2		
Saturation, %	93.7		
Void ratio	0.6496		
Specimen diameter, in.	2.84		
Specimen height, in.	5.68		
Height/diameter ratio	2.00		

Description: brown CLAY

LL = **PL =** **PI =** **Assumed GS= 2.7** **Type:**

Project No.: LV170016

Date Sampled:

Remarks:

Client: Cann-Tech, LLC

Project: Leitchfield Water Treatment Plant Expansion

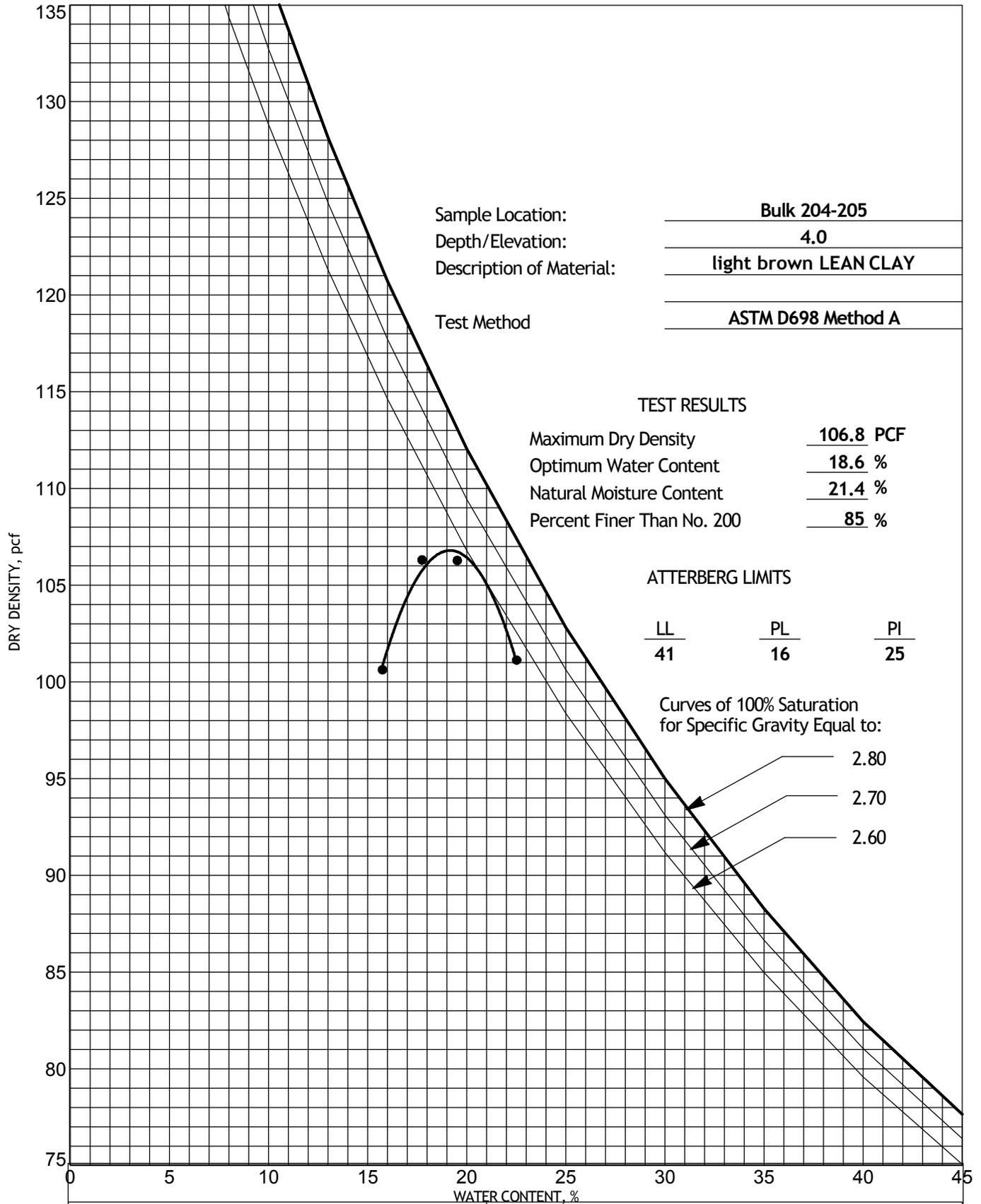
Sample Number: B206 **Depth:** 6.0'



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Figure _____

MOISTURE-DENSITY RELATIONSHIP



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PROJECT INFORMATION

Client: Cann-Tech, LLC
Project Name: Leitchfield Water Treatment Plant Expansion
Project Number: LV170016
Project Location: Leitchfield, Kentucky

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LABORATORY TESTING 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), color and texture. These classification descriptions are included on our "Test Boring Records."

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 D 2487). 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.

Rock Classification: Rock classifications 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 Test Boring Records.

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 D 4318.

Moisture Content: The Moisture Content is determined according to ASTM D 2216.

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.

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.

Compaction Tests: Compaction tests are run on representative soil samples to determine the dry density obtained by a uniform compactive effort at varying moisture contents. The results of the test are used to determine the moisture content and unit weight desired in the field for similar soils. Proper field compaction is necessary to decrease future settlements, increase the shear strength of the soil and decrease the permeability of the soil.

The two most commonly used compaction tests are the Standard Proctor test and the Modified Proctor test. They are performed in accordance with ASTM D 698 and D 1557, respectively. Generally, the Standard Proctor compaction test is run on samples from building or parking areas where small compaction equipment is anticipated. The Modified compaction test is generally performed for heavy structures, highways, and other areas where large compaction equipment is expected. In both tests a representative soil sample is placed in a mold and compacted with a compaction hammer. Both tests have three alternate methods.

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Test	Method	Hammer Wt./ Fall	Mold Diam.	Run on Material Finer Than	No. of Layers	No. of Blows/ Layer
Standard D 698	A	5.5 lb./12"	4"	No. 4 sieve	3	25
	B	5.5 lb./12"	4"	3/8" sieve	3	25
	C	5.5 lb./12"	6"	3/4" sieve	3	56

Test	Method	Hammer Wt./ Fall	Mold Diam.	Run on Material Finer Than	No. of Layers	No. of Blows/ Layer
Modified D 15557	A	10 lb./18"	4"	No. 4 sieve	5	25
	B	10 lb./18"	4"	3/8" sieve	5	25
	C	10 lb./18"	6"	3/4" sieve	5	56

The moisture content and unit weight of each compacted sample is determined. Usually 4 to 5 such tests are run at different moisture contents. Test results are presented in the form of a dry unit weight versus moisture content curve. The compaction method used and any deviations from the recommended procedures are noted in this report.

Laboratory California Bearing Ratio Tests: The California Bearing Ratio, generally abbreviated to CBR, is a punching shear test and is a comparative measure of the shearing resistance of a soil. It provides data that is a semi-empirical index of the strength and deflection characteristics of a soil. The CBR is used with empirical curves to design pavement structures.

A laboratory CBR test is performed according to ASTM D 1883. The results of the compaction tests are utilized in compacting the test sample to the desired density and moisture content for the laboratory California Bearing Ratio test. A representative sample is compacted to a specified density at a specified moisture content. The test is performed on a 6-inch diameter, 4.58-inch-thick disc of compacted soil that is confined in a cylindrical steel mold. The sample is compacted in accordance with Method C of ASTM D 698 or D 1557.

CBR tests may be run on the compacted samples in either soaked or unsoaked conditions. During testing, a piston approximately 2 inches in diameter is forced into the soil sample at the rate of 0.05 inch per minute to a depth of 0.5 inch to determine the resistance to penetration. The CBR is the percentage of the load it takes to penetrate the soil to a 0.1 inch depth compared to the load it takes to penetrate a standard crushed stone to the same depth. Test results are typically shown graphically.

Consolidation Tests: Consolidation tests are conducted on representative soil samples to determine the change in height of the sample with increasing load. The results of these tests are used to estimate the settlement and time rate of settlement of structures constructed on similar soils. A consolidation test is performed according to ASTM D2435 on a single section of an undisturbed sample extruded from a sample tube. The sample is trimmed into a disc 2.5 inches in diameter and 0.75 inch thick. The disc is confined in a stainless steel ring and sandwiched between porous plates. It is then subjected to incrementally increasing vertical loads, and the resulting deformations are measured with a micrometer dial gauge. Void ratio are then calculated from these deformation readings. The test results are typically provided in tabular form or in the form of plots of void ratio versus applied stress (e-log p curves).

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Organic Content: The Organic Content is determined according to ASTM D2974. The moisture content is first determined by drying portions of the sample at 105 degrees Celsius. The ash content is then determined by igniting the oven-dried sample from the moisture content determination in a muffle furnace at 440 degrees Celsius. The substance remaining after ignition is the ash. The organic content is expressed as a percentage by subtracting the percent ash from one hundred.

Direct Shear Tests: Direct shear tests are performed according to ASTM D3080 to determine the shear strength parameters of the soil. The specimen of soil is placed in a rigid box that is divided horizontally into two frames. The specimen is then confined under a vertical or normal stress and horizontal force is applied to fail the specimen along a horizontal plane at its mid-height.

Because drainage of the soil specimen cannot be easily controlled, undrained tests (i.e., UU and CU tests) are possible only on impervious soils and pore pressure measurements cannot be made. Drained tests (i.e., CD tests), however, are possible on all soil types. Since the drainage paths through the specimen are short and pore water pressures are dissipated fairly rapidly, the direct shear test is well suited to the CD test.

A minimum of three test specimens are required to establish the strength envelope of a soil. The soil parameters obtained are the cohesion and angle of internal friction.

Unconfined Compression Tests: The unconfined compression test is an unconsolidated-undrained triaxial shear test with no lateral confining pressure. This test is used to determine the shear strength of clayey soils. An unconfined compression test is performed according to ASTM D2166 on a single section of an undisturbed sample extruded from a sampling tube. The sample is trimmed to a length-to-diameter ratio of about 2 and placed in the testing device. Incrementally increasing vertical loads are applied until the sample fails. Test results are provided in the form of a stress-strain curve or a value representing the unconfined compressive strength of the sample.

Grain Size Tests: Grain Size Tests are performed to determine the soil classification and the grain size distribution. The soil samples are prepared for testing according to ASTM D421 (dry preparation) or ASTM D2217 (wet preparation). The grain size distribution of soils coarser than a number 200 sieve (0.074 mm opening) is determined by passing the samples through a standard set of nested sieves. Materials passing the number 200 sieve are suspended in water and the grain size distribution calculated from the measured settlement rate. These tests are conducted in accordance with ASTM D422.

Triaxial Shear Tests: Triaxial shear tests are used to determine the strength characteristics and friction angle of a given soil sample. Triaxial tests are also used to determine the elastic properties of the soil specimen. Triaxial shear tests are performed on several sections of a relatively undisturbed sample extruded from the sampling tube. The samples are trimmed into cylinders 1.4 to 2.8 inches in diameter and encased in rubber membranes. Each is then placed in a compression chamber and confined by all around water pressure. Samples are then subjected to additional axial and/or lateral loads, depending on the soil and the field conditions to be simulated. The test results are typically presented in tabular form or in the form of stress-strain curves and Mohr envelopes or p-q plots.

Three types of triaxial tests are normally performed. The most suitable type of triaxial test is determined by the loading conditions imposed on the soil in the field and the soil characteristics.

1. Consolidated-Undrained (designated as a CU or R Test).
2. Consolidated-Drained (designated as a CD or S Test).
3. Unconsolidated-Undrained (designated as a UU or Q Test).