Terracon GeoReport

# Geotechnical Engineering Report

**Panda Express S8-19-D6462**

**Shepherdsville, Bullitt County, Kentucky**

May 31, 2018

Terracon Project No. 57185047

**Prepared for:**

Klover Architects

Overland Park, KS

**Prepared by:**

Terracon Consultants, Inc.

Louisville, KY

May 31, 2018

Klover Architects
10955 Lowell Avenue, Suite 700
Overland Park, KS 66210

Attn: Mr. Vu Le, Senior Project Manager
P: (913) 305 4797
E: vu.le@klover.net

Re: Geotechnical Engineering Report
Panda Express S8-19-D6462
Conestoga Parkway and Historical Trail Road
Shepherdsville, Bullitt County, Kentucky
Terracon Project No. 57185047

Dear Mr. Le:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Master Service Agreement dated November 3, 2005 and Task Order dated April 11, 2018. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations, floor slabs, and associated pavements for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
**Terracon Consultants, Inc.**

for

John D. Spears, G.I.T.
Staff Engineering Geologist

STATE OF KENTUCKY
5/31/18
BENJAMIN W. TAYLOR
27823
LICENSED PROFESSIONAL ENGINEER

Benjamin W. Taylor, P.E.
Senior Associate, Office Manager

# REPORT TOPICS



**Note:** This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the Terracon GeoReport logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

# ATTACHMENTS

# Geotechnical Engineering Report

## Panda Express S8-19-D6462
## Conestoga Parkway and Historical Trail Road
## Shepherdsville, Bullitt County, Kentucky

**Terracon Project No. 57185047**
**May 31, 2018**

## INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed restaurant to be located at Conestoga Parkway and Historical Trail Road in Shepherdsville, Bullitt County, Kentucky. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil (and rock) conditions
- Groundwater conditions
- Site preparation and earthwork
- Excavation considerations
- Foundation design and construction
- Floor slab design and construction
- Seismic site classification per IBC
- Pavement design and construction

The geotechnical engineering scope of services for this project included the advancement of eight test borings to depths ranging from approximately 0.2 to 15.2 feet below existing site grades.

Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring logs in the **Exploration Results** section of this report.

## SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

| Item | Description |
|---|---|
| **Parcel Information** | The project is located at Conestoga Parkway and Historical Trail Road in Shepherdsville, Bullitt County, Kentucky. Approximate coordinates for the site are 37.994095°, -85.708390°. Please refer to the **Site Location** plan for additional details. |
| **Existing Improvements** | Based on observations from our site visit, the parcel appears to have been used as borrow site. The existing site grades appear to have been lowered on the order of 5 to 10 feet on the majority the site to or near the top of a shale bedrock. Review of historical aerial photographs indicate earthwork operations began on the site as early as 2004.<br>The site has existing drainage structures with concrete headwalls running from the south-east to the north-west. A drainage swale approximately 10 to 15 feet wide and two feet deep traverses the parcel and intersects the footprint for the proposed building.<br>Existing utility lines are present on the site along the east side of Conestoga Parkway and the south side of Historical Trail Road. Based on site observations, utilities located south of Historical Trail may be within the footprint of the proposed building. |
| **Current Ground Cover** | Based on our site visit, the site is currently un-vegetated (exposed shale bedrock) to moderately vegetated (tall grass with small saplings). |
| **Existing Topography** | An existing topographical survey was provided by senior project manager, Michael Wright, with Land Design & Deployment, Inc., via email with file, 20180514 Existing Cond 17182.pdf, and was transmitted on May 14, 2018.<br>Based on this existing topographic survey provided, the grade generally slopes northwest to the southeast from 449 feet Mean Sea Level (MSL) near the intersection of Conestoga Parkway and Historical Trail Road to 440 feet MSL on the southeastern extent of the parcel. Elevations within the drainage swale are expected to be on the order of 438 to 439 feet MSL. Most of the site is generally flat to gently sloping with grades from 1% to 10% (20 to 6 horizontal: 1 vertical). However, slopes adjacent to the existing drainage swale are up to steeply sloping at about 40% (2.5H:1V). |

We also collected photographs at the time of our field exploration program. Representative photos are provided in our **Photography Log**.

## PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed in the project planning stage. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

| Item | Description |
|---|---|
| **Information Provided** | A site plan was provided by the project architect, Vu Le, with Klover Architects, via email with file, 18-0424 alt layoutXS-R3.4(preferred)-R3.pdf, and was transmitted on April 26, 2018.<br>An existing topographical survey was provided by senior project manager, Michael Wright, with Land Design & Deployment, Inc., via email with file, 20180514 Existing Cond 17182.pdf, and was transmitted on May 14, 2018. |
| **Project Description** | Based on the provided site plan, the proposed improvements cover approximately 0.65 acres and will consist of a building with a footprint of approximately 2,200 square feet and associated pavements consisting of 29 parking spaces. The nearest existing structure to the proposed development is greater than 130 feet away. |
| **Proposed Structure** | Based on email from project architect, Vu Le, on May 7, 2018, the project includes a single-story building with a footprint of about 2,200 square feet. The building will be slab-on-grade (non-basement) with conventional grade beams. |
| **Building Construction** | Based on email from project architect, Vu Le, on May 7, 2018, the proposed structure will be a wood-framed building with slab-on-grade and brick or stone claddings. |
| **Finished Floor Elevation** | Based on email from senior project manager, Michael Wright, with Land Design and Development on May 8, 2018, finished floor elevation is expected to be about 450.4 feet MSL, based on a floodplain elevation of 448.9 feet MSL. This will result in expect fill heights of 6 to 12 feet within the building footprint. |
| **Maximum Loads** | Based on email from project architect, Vu Le, on May 7, 2018, the following loading conditions are anticipated.<br>■ Columns: 75 kips<br>■ Walls: 3 kips per linear foot (klf)<br>■ Slabs: 125 pounds per square foot (psf)<br>If loading conditions vary from those stated above, Terracon should be retained to review the recommendations in this report. |
| **Grading/Slopes** | Finished floor elevation will be at 450.4 feet MSL. A grading plan has not been provided to date, but less +/-2 feet of cut and up to 12 feet of fill is expected to develop final grade. Final slope angles are expected to be 3H:1V or flatter. |

| Item | Description |
|---|---|
| **Below Grade Structures/ Below Grade Areas** | Existing drainage swales are expected to be rerouted outside the proposed building's footprint. |
| **Free-Standing Retaining Walls** | Based on email from project architect, Vu Le, on May 7, 2018, retaining walls are not expected to constructed as part of site development to achieve final grades. |
| **Pavements** | Based on email from project architect, Vu Le, on May 7, 2018, paved driveway and parking will be constructed on approximately 0.35 acres of the parcel. We expect both rigid (concrete) and flexible (asphalt) pavement sections should be considered.<br>Anticipated traffic is as follows, based on similar projects:<br>■ Autos/light trucks: 400 vehicles per day<br>■ Light delivery and trash collection vehicles: 1 vehicle per day<br>■ Tractor-trailer trucks: 1 vehicle per day<br>The pavement design period is 20 years. |
| **Estimated Start of Construction** | Based on email from project architect, Vu Le, on May 7, 2018, earth work is expected to begin in Summer 2018 |

# GEOTECHNICAL CHARACTERIZATION

## Regional Overburden Geology

Based on review of mapping by the Kentucky Geologic Survey (KGS), surficial geology consists of alluvium and lacustrine deposits, clay, medium gray, weathers very light gray to yellowish gray and grayish orange, silty, calcareous.

**Man-Made (Fill)**: Undocumented fill was encountered near Historical Trail Road. Fill soils are those soils that have been placed or reworked in conjunction with past construction grading. Fill can be composed of different soil types from various sources and can contain debris from building demolition or roadway construction, organics, topsoil, trash, etc. The engineering properties of the fill depend primarily on its composition, density, and moisture content and can be highly variable depending on the control exercised during placement and compaction. Fill depths and site specific details are discussed in the following section.

## Regional Bedrock Geology

| Formation | Description |
|---|---|
| **New Albany Shale, Beechwood & Louisville Limestone** [1] | Per Kentucky Geologic Survey (KGS), geology in the area is comprised of the New Albany Shale and the Beechwood and Louisville Limestones of the Sulurian and Devonian Age. These members may be generally described as:<br>■ Shale, black to gray, pyritic, calcareous, with phosphates<br>■ Limestone, dolomitic, pyritic, calcareous, narrow steep solution cavities, with small sinks<br>The area of the site has a generally low karst potential according to the KGS's karst potential map. However, the nearest mapped sinkhole is less than 0.8 miles from the site. |

1. Based on the Shepherdsville Quadrangle Map of Bullitt County, Kentucky, published by the U.S. Geological Survey (GQ-740), retrieved on May 9, 2018.

## Subsurface Profile

We have developed a general characterization of the subsurface soil and groundwater conditions based upon our review of the data and our understanding of the geologic setting and planned construction. The following table provides our geotechnical characterization.

The geotechnical characterization forms the basis of our geotechnical calculations and evaluation of site preparation, foundation options and pavement options. As noted in **General Comments**, the characterization is based upon widely spaced exploration points across the site, and variations are likely.

| Stratum | Approximate Depth to Bottom of Stratum (feet) | Material Description | Consistency/Density SPT [1] N-Value Range (bpf) HP [2] Value Range (tsf) |
|---|---|---|---|
| Surface [3] | 0.0 to 1.0 | Topsoil: brown, friable and contained significant organic matter | N/A |
| Man-Made (Fill) [4] | 1.5 to 6.0 | Existing Fill – Lean to Moderate Plasticity Clay (CL), with varying amounts of rubble (i.e. shale and asphalt fragments) and hydro-carbon odor | N/A<br>N-Value Range: 1 to 10<br>HP Value Range: 0.5 to 1.75 |
| 1 | 1.5 to 2.5 | Lean Clay to Moderate Plasticity Clay (CL) [5] | Medium Stiff to Very Stiff<br>N-Value Range: 5 to 28<br>HP Values Range: 1.0 to 3.5 |
| 3 | 0.2 to 10.2 | Weathered Rock (Shale) | Generally characterized as completely weathered and extremely weak (soft) [6]<br>N-Value Range: 26 to 50/5” |
| 4 | 11.5 | Rock – Shale,<br>with hydro-carbon odor | Generally characterized as slightly weathered and weak [6] |
| 5 | Undetermined: Borings terminated within this stratum at approximately 15.2 feet | Rock – Limestone,<br>vuggy | Generally characterized as moderately weathered and weak [6] |

1. Standard Penetration Test (SPT) N-Value Range in units of blows per foot (bpf).
2. HP (Hand Penetrometer) Range in tons per square foot (tsf).
3. Borings B-1, P-2, P-4, and P-6 had negligible topsoil. The remaining borings had topsoil ranging from 0.7 to 1.0 feet.
4. Existing fill was encountered at borings B-2, P-5, and P-6 and should be anticipated at other locations onsite. Apparent hydro-carbon odor was noted at P-5 only within fill.
5. Native clay was encountered at borings B-1, P-1, and P-3. Atterberg limits testing on representative samples resulted in liquid limit (LL) ranging from 38 to 47 percent and plastic limit (PL) ranging from 24 to 25 percent. Moisture content tests on representative samples ranged from 17 to 26 percent.
6. Refer to Description of Rock Properties in Supporting Information. Hydro-carbon odor noted at B-2 only.

Conditions encountered at each boring location are indicated on the individual boring logs shown in the **Exploration Results** section and are attached to this report. Stratification boundaries on the boring logs represent the approximate location of changes in native soil types; in situ, the transition between materials may be gradual.

## Groundwater Conditions

The boreholes were observed while drilling and after completion for the presence and level of groundwater. In addition, delayed water levels were also obtained in some borings. The water levels observed in the boreholes can be found on the boring logs in **Exploration Results**, and are summarized below. Ground water observations ranged in elevations from 439 to 443 feet MSL.

| Boring Number | Groundwater Observations while Drilling | | Groundwater Observations after Drilling | |
|---|---|---|---|---|
| | Approximate Depth (feet) [1] | Approximate Elevation (feet) [2] | Approximate Depth (feet) [1] | Approximate Elevation (feet) [2] |
| B-2 | 4.5 | 441.5 | 3.2 (8 hr. reading) | 443 |
| P-3 | 1.5 | 440.5 | 0.6 (2.5 hr. reading) | 441.4 |
| P-4 | 1 | 440.7 | No water observed after 3 hr. | N/A |
| P-5 | No water observed while drilling | N/A | 7 (at completion of drilling) | 439 |

1. Below existing ground surface
2. Above Mean Sea Level (MSL)

Groundwater was not observed in the remaining borings while drilling, or for the short duration the borings could remain open. However, this does not necessarily mean the borings terminated above groundwater, or the water levels summarized above are stable groundwater levels. Due to the low permeability of the soils encountered in the borings, a relatively long period may be necessary for a groundwater level to develop and stabilize in a borehole. Long term observations in piezometers or observation wells sealed from the influence of surface water are often required to define groundwater levels in materials of this type. Based on the depth of undocumented fill with respect to observed groundwater levels, the contractor should be prepared to dewater excavations during earthwork for site grading, if needed.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project. This project has potential for trapped/perched water with the uncontrolled fill and at the fill-natural soil interface and at the soil-bedrock interface.

## GEOTECHNICAL OVERVIEW

The following geotechnical engineering considerations were identified:

**Existing Fill:** As noted in **Geotechnical Characterization**, borings B-2, P-5, and P-6 encountered existing fill to depths ranging from about 1.5 to 6.0 feet. The fill does not appear to have been placed in a controlled manner. The encountered fill consisted of predominately lean clay with rubble (i.e. asphalt and shale fragments) and hydro-carbon odor noted in some parts of the fill. Furthermore, we have no records to indicate the degree of control. Therefore, the existing fill is considered undocumented. Support of foundations, pavements, and floor slabs on or above existing fill soils is not recommended based on the apparent uncontrolled nature as well as the apparent composition including potentially pyritic New Albany Shale which can cause heaving due to expansion over time. This risk cannot be eliminated without completely removing the existing fill.

New Albany Shale is described by the Kentucky Geological Survey as calcareous pyritic shale. Pyritic shales have potential to swell causing a wide range of construction issues (ie. foundation heave, floor heave, masonry cracking, pavement distress, etc.) affecting new construction. Based on local experience, apparent New Albany Shale was identified within the fill at boring P-5.

**Existing Utilities and Drainage Structures:** Existing drainage structures are present at the site and are currently within the footprint of the proposed building. Additionally, based on site observations during exploration, it appears that existing utilities (including a gas line) may be very close to the proposed building and may effect site preparation and foundation construction, particularly on the north side of the proposed building and south of Historical Trail Road. These structures/utilities should be relocated at least 10 feet outside the proposed building's footprint. Any abandoned underground pipes left in place should be fully grouted. Excavations created due to utility relocations should be backfilled with lean concrete, flowable fill, or structural fill material.

**Shallow Foundations:** The **Shallow Foundations** section addresses support of the building bearing on structural fill overlaying soft weathered native rock. In summary, undocumented fill and compressible native soils were encountered at the site. To help control total and differential settlements, undocumented fill and compressible native soils should be undercut to at least soft weathered rock, then replaced with new structural fill. An allowable bearing capacity of 3,500 psf can be used to dimension wall and column footings.

**Excessive Total and Differential Settlement:** Based on our understanding of the proposed site grading, fill heights will range from about 6 to 12 feet within the building pad. This report recommends that the existing fill and medium stiff soils encountered at borings B-1 and B-2 are removed during site grading and replaced with new structural fill. Even with this measure, experience shows that settlements within compacted structural fill due to self-weight may

approach 1/8th of an inch per foot with 50% occurring as the fill is being placed. Therefore settlement, particularly differential settlement, associated with variable fill heights and structural loads may exceed allowable tolerances. The self-weight fill settlement can be reduced by using a granular fill and can be monitored, through the installation of settlement pins. Settlement pins should be monitored by a surveyor at completion of fill placement with foundation construction delayed until 4 consecutive weeks are documented with less than 1/8th of settlement.

**Floor Slabs and Pavements**: The **Floor Slabs** section addresses slab-on-grade support of the building. The **Pavements** section addresses the design of pavement systems. Support of floor slabs and pavements on or above existing fill soils is not recommended. Native subgrade soils should pass a heavy proofroll. Deeper undercuts may be required based on the results of the proofroll or may require underlayment by a geosynthetic at the base of the excavation. Additional site preparation recommendations including subgrade improvement and fill placement are provided in the **Earthwork** section.

The near surface soils could become unstable with typical earthwork and construction traffic, especially after precipitation events. The effective drainage should be completed early in the construction sequence and maintained after construction to avoid potential issues. If possible, the grading should be performed during the warmer and drier time of the year. If grading is performed during the winter months, an increased risk for possible undercutting and replacement of unstable subgrade will persist. Additional site preparation recommendations including subgrade improvement and fill placement are provided in the **Earthwork** section.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The **General Comments** section provides an understanding of the report limitations.

# EARTHWORK

Earthwork will include clearing and grubbing, excavations and fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria as necessary to render the site in the state considered in our geotechnical engineering evaluation for foundations, floor slabs, and pavements.

Based on site observations during our exploration program, it appears that existing utilities (including a gas line) may be very close to the proposed building and may effect site preparation and foundation construction, particularly on the north side of the proposed building and south of Historical Trail Road.

## Site Preparation

Undocumented fill was encountered at this site with depths ranging from 1.5 to 6 feet below existing site grades. Weathered shale bedrock was encountered exposed at the ground surface up to about 6.0 feet below existing grade. Based on the finished floor elevation provided, we expect structural fill with a thickness on the order of 8 to 12 feet will be required reach planned grades. We recommend that earthwork observation and testing be conducted during placement of the structural fill.

Prior to placing structural fill, existing vegetation, topsoil, root mat and existing fill should be completely removed. Due to variability in the lateral extent of the undocumented fill as well as the apparent uncontrolled nature and incorporation of potential pyritic shale, all undocumented existing fill should be undercut and removed. For the building pad area, it is additionally recommended to undercut all soft to medium stiff native soils and fill to the to the top of the weathered shale bedrock corresponding to an elevation of about 440 to 442 feet MSL. The undercutting should extend lateral 10 feet outside the proposed construction footprint.

For the proposed pavement and floor slab areas, the subgrade should then be proof-rolled with an adequately loaded vehicle such as a fully loaded tandem axle dump truck. The proof-rolling should be performed under the direction of the Geotechnical Engineer. Areas excessively deflecting under the proof-roll should be delineated and subsequently addressed by the Geotechnical Engineer. Such areas should either be removed, modified, or mechanically or chemically stabilized as appropriate. Excessively wet or dry material should either be removed or moisture conditioned and recompacted.

## Fill Material Types

Fill required to achieve design grade should be classified as structural fill and general fill. Structural fill is material used below, or within 10 feet of structures, pavements or constructed slopes. Earthen materials used for structural and general fill should meet the following material property requirements:

| Soil Type [1] | USCS Classification | Physical Properties | Acceptable Locations for Placement |
|---|---|---|---|
| Low Plasticity Cohesive | CL, CL-ML ML, SM, SC | LL < 40 6 ≤ PI ≤ 25 | Pavement Areas and general/non-structural areas |
| Moderate to High Plasticity Cohesive [2] | CH, MH, CL | 40 ≤ LL< 50 | Used in general/non-structural areas |
| Silty Granular [3] | GM, SM | ≥30% passing the #4 sieve PI ≤ 4 | All locations and elevations |

1. Structural and general fill should consist of approved materials free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to use on this site.
2. Moderate plasticity clays were encountered within the undocumented fill in borings B-1 and P-5. These soils should be anticipated at other locations within the proposed project area and should not be used within 2 feet of finished grade of the building area. If CH or MH soils are encountered, they should not be used within 3 feet of finished grade in building area and 1 foot below finished grade in other structural fill areas.
3. To reduce settlements to within tolerable limits and the time needed for settlement monitoring, a crushed stone that meet KYTC specifications for Dense Graded Aggregate Base (DGA) should be used within the building footprint.

Based on local experience, apparent New Albany Shale was identified within the fill at boring P-5. Additionally, New Albany Shale have been known to be used for fill by local subcontractors in the area. Therefore, imported material to be used as structural fill should be evaluated by a geotechnical engineer or representative, prior to placement.

## Fill Compaction Requirements

Structural and general fill should meet the following compaction requirements.

| Item | Structural Fill | General Fill |
|---|---|---|
| **Maximum Lift Thickness** | 8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used<br>4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used | Same as Structural fill |
| **Minimum Compaction Requirements** [1, 2, 3] | 98% of max. below foundations and within 1 foot of finished pavement subgrade<br>95% of max. above foundations, below floor slabs, and more than 1 foot below finished pavement subgrade | 92% of max. |
| **Water Content Range** [1] | Low plasticity cohesive: -2% to +3% of optimum<br>High plasticity cohesive: 0 to +4% of optimum<br>Granular: -3% to +3% of optimum | As required to achieve min. compaction requirements |

1. Maximum density and optimum water content as determined by the standard Proctor test (ASTM D 698).
2. High plasticity cohesive fill should not be compacted to more than 100 percent of standard Proctor maximum dry density.
3. If the granular material is a coarse sand or gravel, or of a uniform size, or has a low fines content, compaction comparison to relative density may be more appropriate. In this case, granular materials should be compacted to at least 70% relative density (ASTM D 4253 and D 4254).

Onsite materials that are expected to be over-excavated and possibly reused as structural fill had moisture contents ranging from 13 to 26 percent. In-situ moisture contents are expected to be generally above optimum moisture contents based on published colorations. Therefore, drying and/or modification may be needed to reach optimum moisture contents of removed soils prior to re-compaction.

## Utility Trench Backfill

Removal and/or relocation of any “to be abandoned” utilities or drainage swales, as well as installation of new underground utilities, should be performed once the topsoil and any deleterious material has been removed and prior to mass excavation. Any abandoned underground pipes left in place should be fully grouted. This can be especially critical for abandoned utilities that extend into any deep excavation(s) which may potentially allow water to flow virtually unimpeded into excavations. Excavations created due to utility relocations should be backfilled with lean concrete, flowable fill, or granular structural fill material, placed and compacted in accordance with the recommendations provided in this report.

All trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction. If utility trenches are backfilled with relatively clean

granular material, they should be capped with at least 18 inches of cohesive fill in non-pavement areas to reduce the infiltration and conveyance of surface water through the trench backfill.

For low permeability subgrades, utility trenches are a common source of water infiltration and migration. Utility trenches penetrating beneath the building should be effectively sealed to restrict water intrusion and flow through the trenches, which could migrate below the building. The trench should provide an effective trench plug that extends at least 5 feet from the face of the building exterior. The plug material should consist of cementitious flowable fill or low permeability clay. The trench plug material should be placed to surround the utility line. If used, the clay trench plug material should be placed and compacted to comply with the water content and compaction recommendations for structural fill stated previously in this report.

## Grading and Drainage

All grades must provide effective drainage away from the building during and after construction and should be maintained throughout the life of the structure. Water retained next to the building can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. The roof should have gutters/drains with downspouts that discharge onto splash blocks at a distance of at least 10 feet from the building.

Exposed ground should be sloped and maintained at a minimum 5 percent away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted as necessary as part of the structure's maintenance program. Where paving or flatwork abuts the structure a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

## Earthwork Construction Considerations

Shallow excavations, for the proposed structure, are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of floor slabs. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over, or adjacent to, construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted, prior to floor slab construction.

Perched groundwater within the undocumented fill should be expected and groundwater could affect over-excavation efforts, especially for over-excavation and replacement of lower strength soils. A temporary dewatering system consisting of sumps with pumps could be necessary to achieve the recommended depth of over-excavation.
As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local, and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

## Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of adequate removal of vegetation and top soil, proof-rolling and mitigation of areas delineated by the proof-roll to require mitigation.

Each lift of compacted fill should be tested, evaluated, and reworked as necessary until approved by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the building areas and 5,000 square feet in pavement areas. One density and water content test for every 50 linear feet of compacted utility trench backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. In the event that unanticipated conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

## SHALLOW FOUNDATIONS

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations.

The existing fill and medium stiff soils are not suitable for development of the proposed project and should be removed and replaced with new structural fill or modified by ground improvement measures. If undercut and replaced, we expect this will result in new structural fill ranging from about 6 to 12 feet (to the bottom of the drainage swale) based on the provided finished floor elevation of 450.4 feet MSL within the proposed building footprint.

Experience shows that settlements within compacted structural fill due to self-weight may approach 1/8$^{th}$ of an inch per foot with 50% occurring as the fill is being placed. Therefore, settlement associated with variable fill heights and combined structural loads may exceed allowable tolerances, particularly for differential settlement. Settlements within the fill can be reduced by using a select granular structural fill material. Settlement pins should be monitored by a surveyor at completion of fill placement with foundation construction delayed until 4 consecutive weeks are documented with less than 1/8$^{th}$ of settlement. Alternatively, post-construction settlement can be mitigated using ground improvement such as stone columns, which could also alleviate the need to undercut existing fill and medium stiff soils within the building pad.

### Design Parameters – Compressive Loads

| Item | Description |
|---|---|
| **Maximum Net Allowable Bearing pressure** [1,2] | 3,500 psf bearing on new structural fill<br>Stone columns: to be provided by specialty contractor |
| **Required Bearing Stratum** [3] | Structural fill overlaying weathered shale bedrock or ground improvement elements |
| **Minimum Foundation Dimensions** | Columns: 24 inches<br>Continuous: 18 inches |
| **Ultimate Passive Resistance** [4] **(equivalent fluid pressures)** | 390 psf for structural fill |
| **Ultimate Coefficient of Sliding Friction** [4,5] | 0.45 (clay or sand structural fill)<br>0.55 (gravel structural fill) |
| **Minimum Embedment below Finished Grade** [6] | 24 inches below final grade to limit frost and seasonal moisture variations |
| **Estimated Total Settlement from Structural Loads** [2] | Granular [8] structural fill: about 1 inch<br>Cohesive structural fill: approaching 2 inches<br>Stone columns: to be provided by specialty contractor |

| Item | Description |
|---|---|
| **Estimated Differential Settlement** [2,7] | Granular [8] structural fill: about 1/2 of total settlement<br>Cohesive structural fill: approaching 1 inch<br>Stone columns: to be provided by specialty contractor |

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. An appropriate factor of safety has been applied. These bearing pressures can be increased by 1/3 for transient loads unless those loads have been factored to account for transient conditions. Values assume that exterior grades are no steeper than 20% within 10 feet of structure.
2. Values provided are for maximum loads noted in **Project Description**.
3. Unsuitable, medium stiff or softer soils should be over-excavated and replaced per the recommendations presented in **Earthwork**.
4. Use of passive earth pressures require the sides of the excavation for the footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted structural fill be placed against the vertical footing face. If the loaded side is sloped or benched, and then backfilled, the allowable passive pressure will be significantly reduced. Passive resistance in the upper 3 feet of the subsurface profile should be neglected. If passive resistance is considered in design, then the sliding friction should be ignored.
5. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Should be neglected for foundations subject to net uplift conditions.
6. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.
7. Differential settlements are as measured over a span of 50 feet.
8. To reduce settlements to within tolerable limits and the time needed for settlement monitoring, a crushed stone that meet KYTC specifications should be used within the building footprint.

## Construction Adjacent to Existing Utilities

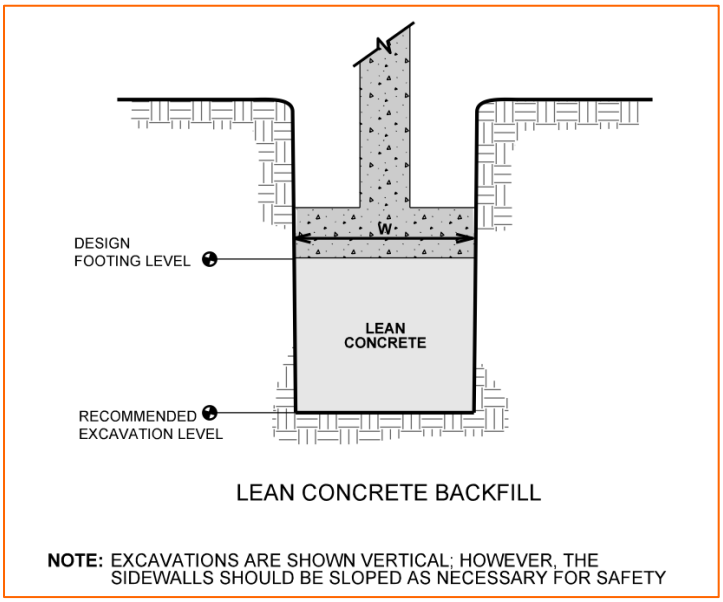
Based on our site visit, markings for an existing gas and communications line are expected to be within 10 feet of the north side of the proposed building or possibly within the footprint of the footings. As such, these utilities should be relocated 10 feet outside the proposed building or the building should be relocated as to provide at least a 10-foot buffer. If the gas line is to remain near the building, Terracon can provide a shoring design upon request. Refer to the enclosed, photography log for observations made during our exploration program.

## Foundation Construction Considerations

As noted in **Earthwork**, the footing excavations should be evaluated under the direction of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

If unsuitable bearing soils are encountered at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on

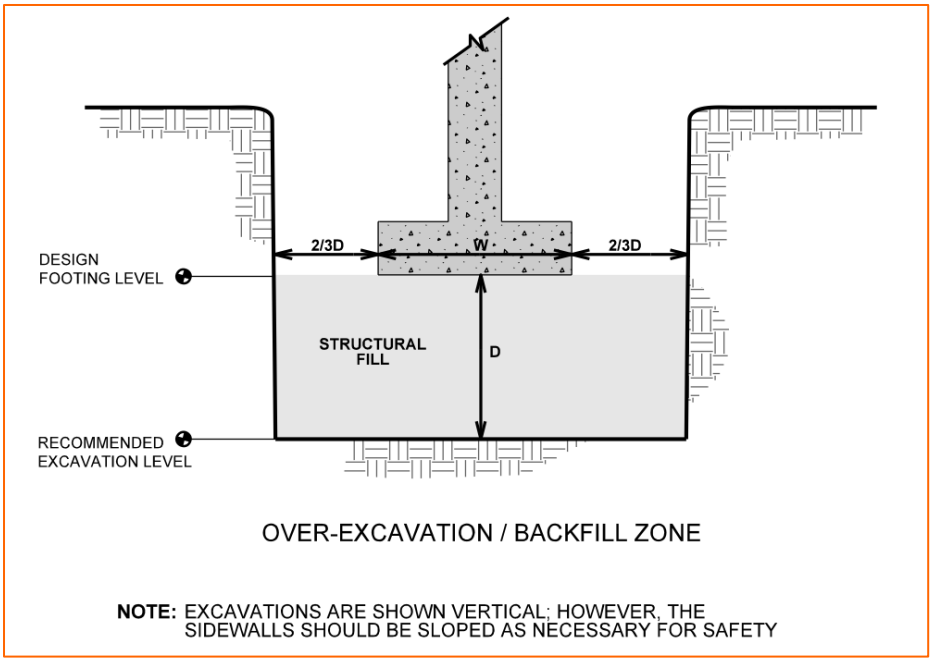
these soils at the lower level or on lean concrete backfill placed in the excavations. This is illustrated on the sketch below.




LEAN CONCRETE BACKFILL

**NOTE:** EXCAVATIONS ARE SHOWN VERTICAL; HOWEVER, THE SIDEWALLS SHOULD BE SLOPED AS NECESSARY FOR SAFETY

Over-excavation for structural fill placement below footings should be conducted as shown below. The over-excavation should be backfilled up to the footing base elevation, with a low volume change material placed, as recommended in the **Earthwork** section.




OVER-EXCAVATION / BACKFILL ZONE

**NOTE:** EXCAVATIONS ARE SHOWN VERTICAL; HOWEVER, THE SIDEWALLS SHOULD BE SLOPED AS NECESSARY FOR SAFETY

## GROUND IMPROVEMENT

As an alternative to removal of the existing fill followed by placement of select granular fill, or delaying construction for settlements within new cohesive structural fill, the foundations and floor slabs could be supported on ground improvement, particularly stone column elements. Ground improvement methods are proprietary systems designed by licensed contractors who could provide further information regarding support options. General comments concerning this approach are provided in the subsequent paragraphs.

The installer should provide detailed design calculations sealed by a professional engineer licensed in the State of Kentucky. The design calculations should demonstrate that improvement elements are estimated to control long-term settlements to less than 1 inch total and ½-inch differential. Upon completing a preliminary design of a ground improvement system to support the structure, a design/construction cost estimate should be provided, including the estimated time to install the elements. This estimate should include the cost to provide full-scale load testing required to verify design assumptions. The load test provides a conservative measure of the stiffness of the element and will provide quality control guidelines for the pier installation procedures. The load test, where required, should be performed in the general area of the site considered to be representative of the most critical soil condition.

It is recommended that a representative of the geotechnical engineer monitor installer's activities as a Quality Assurance service. Terracon's services will supplement the installer's internal Quality Control program.

## SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7-10.

| Description | Value |
|---|---|
| **2012 International Building Code Site Classification** | C (E) [1,2,3,4] |
| **Site Latitude** | 37.994095° |
| **Site Longitude** | -85.708390° |

1. Seismic site classification in general accordance with the *2012 International Building Code*, which refers to ASCE 7-10.
2. The 2012 International Building Code (IBC) uses a site profile extending to a depth of 100 feet for seismic site classification. Borings at this site were extended to a maximum depth of 15.2 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.
3. Assumes that foundations will be extended through all existing fill and medium stiff or softer soils or be undercut and replaced with structural fill overlying at least soft weathered rock. Otherwise site classification would be E depending on the unknown variability of the undocumented fill.
4. Assumes that structural fill will be placed per the recommendations presented in the **Earthwork** section.

## FLOOR SLABS

It should be understood that without ground improvement or complete removal and replacement of undocumented fill, there will be risk of poor floor slab performance over time and increased frequency of maintenance maybe required. Full undercut and replacement should be performed, if a minimal risk option is desired.

Settlement of floor slabs supported on existing fill materials cannot be accurately predicted, but could be larger than normal and result in some cracking. Mitigation measures as noted in **Existing Fill** within **Earthwork** and below are critical to the performance of floor slabs. In addition to the mitigation measures, the floor slab can be stiffened by adding steel reinforcement, grade beams and/or post-tensioned elements. If the risk associated with undocumented fill cannot be accepted, the undocumented fill should be completely removed.

Design parameters for floor slabs assume the requirements for **Earthwork** have been followed. Specific attention should be given to positive drainage away from the structure and positive drainage of the aggregate base beneath the floor slab.

## Floor Slab Design Parameters

| Item | Description |
|---|---|
| **Floor Slab Support** [1] | At least stiff native soil or new structural fill |
| **Estimated Modulus of Subgrade Reaction** [2] | 125 pounds per square inch per inch (psi/in) for point loads |
| **Aggregate base course/capillary break** | Minimum 6 inches of free-draining (less than 6% passing the U.S. No. 200 sieve) crushed aggregate compacted to at least 95% of ASTM D 698 [2, 3] |

1. Floor slabs should be structurally independent of building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.
2. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in **Earthwork**, and the floor slab support as noted in this table. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.
3. Free-draining granular material should have less than 5 percent fines (material passing the #200 sieve). Other design considerations such as cold temperatures and condensation development could warrant more extensive design provisions.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations refer to the ACI Design Manual. Joints or cracks should be sealed with a water-proof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

## Floor Slab Construction Considerations

Finished subgrade within and for at least 10 feet beyond the floor slab should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are

constructed. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed and structural fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

The Geotechnical Engineer should approve the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

# PAVEMENTS

## General Pavement Comments

Pavement designs are provided for the traffic conditions and pavement life conditions as noted in **Project Description** and in the following sections of this report. A critical aspect of pavement performance is site preparation. Pavement designs, noted in this section, must be applied to the site, which has been prepared as recommended in the **Earthwork** section.

Support characteristics of subgrade for pavement design do not account for shrink/swell movements of an expansive clay subgrade, such as soils encountered on this project. Thus, the pavement may be adequate from a structural standpoint, yet still experience cracking and deformation due to shrink/swell related movement of the subgrade.

## Pavement Design Parameters

Design of Asphaltic Concrete (AC) pavements are based on the procedures outlined in the *Kentucky Transportation Cabinet (KYTC) Pavement Design Guide*, dated February 2007, as well as procedures outlined in the 1993 Guide for Design of Pavement Structures by the American Association of State Highway and Transportation Officials (AASHTO-1993). Design of Portland Cement Concrete (PCC) pavements are based upon American Concrete Institute (ACI) 330R-01; Guide for Design and Construction of Concrete Parking Lots.

A subgrade CBR of 3 was used for the AC pavement designs, and a modulus of subgrade reaction of 100 pci was use for the PCC pavement designs. The values were empirically derived based upon our experience with the describe soil type subgrade soils and our understanding of the quality of the subgrade as prescribed by the **Site Preparation** conditions as outlined in **Earthwork**. A modulus of rupture of 600 psi was used for pavement concrete.

## Pavement Section Thicknesses

The following table provides options for AC and PCC Sections:

| Asphaltic Concrete Design | | |
|---|---|---|
| **Layer** | **Thickness (inches)** | |
| | **Drive Lanes/Exits/Entrances [1]** | **Automobile Parking [1]** |
| AC – Surface [2,3] | 1 ½ | 1 ½ |
| AC – Binder [2,4] | 2 ½ | 2 ½ |
| Aggregate Base [2,5] | 8 | 6 |
| Total Thickness | 12 | 10 |

1. See **Project Description** for more specifics regarding Light Duty and Medium Duty traffic.
2. All materials should meet the current state, county, and local specifications for highway and bridge construction.
3. A minimum 1.5-inch surface course should be used on ACC pavements.
4. Specifications for Asphalt Surface and Binder (PG 64-22) are available at: http://transportation.ky.gov/construction/pages/kentucky-standard-specifications.aspx.
5. Aggregate base material should consist of a crushed stone material that meet KYTC specifications for Dense Graded Aggregate Base (DGA).

| Portland Cement Concrete Design | | | |
|---|---|---|---|
| **Layer** | **Thickness (inches)** | | |
| | **Automobile Parking [1]** | **Drive Lanes/Exits/Entrances [1]** | **Dumpster Pad [4]** |
| PCC [2] | 5 | 6 | 8 |
| Aggregate Base [2,3] | 4 | 6 | 6 |
| Total Thickness | 9 | 12 | 14 |

1. See **Project Description** for more specifics regarding traffic classifications.
2. All materials should meet the current state, county, and local specifications for highway and bridge construction.
3. Aggregate base material should consist of a crushed stone material that meet KYTC specifications for Dense Graded Aggregate Base (DGA).
4. In areas of anticipated heavy traffic, fire trucks, delivery trucks, or concentrated loads (e.g. dumpster pads), and areas with repeated turning or maneuvering of heavy vehicles. The trash container pad should be large enough to support the container and the tipping axle of the collection truck.

## Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.

Based on the possibility of shallow and/or perched groundwater, we recommend installing a pavement subdrain system to control groundwater, improve stability, and improve long term pavement performance.

Due to frost-susceptible soils and the possibility of perched groundwater, consideration should be given to installing a pavement subdrain system to control subgrade moisture, improve stability, and improve long term pavement performance.

We recommend at least 6 inches of free-draining granular material should be placed beneath the pavements. The use of a free draining granular base will also reduce the potential for frost action. We recommend pavement subgrades be crowned at least 2 percent, to promote the flow of water towards the subdrains, and to reduce the potential for ponding of water on the subgrade. The design recommendations for the subdrains are provided in the following table:

| Subdrain Design Recommendations | |
|---|---|
| **Item** | **Value** |
| **Free Draining Granular Base Thickness below Pavement** | 6 inches of material meeting No. 57 aggregate specifications |
| **Minimum Drain Pipe Diameter** | 4 inches |
| **Drain Trench Width** | 16 inches or greater to provide minimum 6-inch annulus of drainage aggregate around drain pipe. |
| **Invert Depth below Subgrade Elevation** | 3½ feet |
| **Maximum Drain Pipe Spacing** | 50 feet |
| **Subdrain Trench Backfill Material** | No. 57 aggregate or ¾-inch aggregate |

The subdrains should be hydraulically connected to the free-draining granular base layer. Subdrains should be sloped to provide positive gravity drainage to reliable discharge points such as the storm water detention basin. Periodic maintenance of subdrains is required for long-term proper performance.

The pavement surfacing and adjacent sidewalks should be sloped to provide rapid drainage of surface water. Water should not be allowed to pond on or adjacent to these grade-supported slabs, since this could saturate the subgrade and contribute to premature pavement or slab deterioration.

The pavement surfacing and adjacent sidewalks should be sloped to provide rapid drainage of surface water. Water should not be allowed to pond on or adjacent to t slabs, since it could saturate the subgrade and contribute to premature pavement or slab deterioration.

## Pavement Maintenance

The pavement sections represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore, preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Maintenance consists of both localized maintenance (e.g. crack and joint sealing and patching) and global maintenance (e.g. surface sealing). Preventive maintenance is usually the priority when implementing a pavement maintenance program. Additional engineering observation is recommended to determine the type and extent of a cost-effective program. Even with periodic maintenance, some movements and related cracking may still occur and repairs may be required.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to paved areas should slope down from the edges at a minimum 2%.
- Subgrade and pavement surfaces should have a minimum 2% slope to promote proper surface drainage.
- Install below pavement drainage systems surrounding areas anticipated for frequent wetting.
- Install joint sealant and seal cracks immediately.
- Seal all landscaped areas in or adjacent to pavements to reduce moisture migration to subgrade soils.
- Place compacted, low permeability backfill against the exterior side of curb and gutter.
- Place curb, gutter and/or sidewalk directly on clay subgrade soils rather than on unbound granular base course materials.

## GENERAL COMMENTS

As the project progresses, we address assumptions by incorporating information provided by the design team, if any. Revised project information that reflects actual conditions important to our services is reflected in the final report. The design team should collaborate with Terracon to confirm these assumptions and to prepare the final design plans and specifications. This facilitates the incorporation of our opinions related to implementation of our geotechnical recommendations. Any information conveyed prior to the final report is for informational purposes only and should not be considered or used for decision-making purposes.

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in the final report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our scope of services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third party beneficiaries intended. Any third party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

# ATTACHMENTS

# EXPLORATION AND TESTING PROCEDURES

## Field Exploration

| Number of Borings | Boring Depth (feet) | Planned Location |
|---|---|---|
| 2 | 5.5 to 15.2 | Proposed Building |
| 6 | 0.2 to 8.0 | Proposed Pavements |

**Boring Layout and Elevations:** Unless otherwise noted, Terracon personnel provide the boring layout. Boring locations were adjusted in the field based on site accessibility. Coordinates and elevations were obtained with a survey grade GPS unit (estimated horizontal and vertical accuracy of about ±1 feet). If elevations and a more precise boring layout are desired, we recommend borings be surveyed following completion of fieldwork.

**Subsurface Exploration Procedures:** We advance the borings with a trailer-mounted, rotary drill rig using continuous flight augers (solid stem and/or hollow stem as necessary depending on soil conditions). Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. Representative soil samples were obtained by the split-barrel sampling procedure. In this procedure, the number of blows required to advance a standard 2-inch O.D. split-barrel sampler the last 12 inches of the typical total 18-inch penetration by means of a 140-pound automatic hammer with a free fall of 30 inches is the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. This value is used to estimate the *in situ* relative density of cohesionless soils and the consistency of cohesive soils.

We observe and record groundwater levels during drilling and sampling. For safety purposes, all borings are backfilled with auger cuttings after their completion. Pavements were patched with cold-mix asphalt and/or pre-mixed concrete, as appropriate.

The sampling depths, penetration distances, and other sampling information were recorded on the field boring logs. The samples were then placed in appropriate containers and taken to our soil laboratory for testing and classification by a geotechnical engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs include visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the geotechnical engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

The descriptions of the soils indicated on the boring log are in general in accordance with the enclosed General Notes and the Unified Soil Classification System. Estimated group symbols

according to the Unified Soil Classification System are given on the boring log. A brief description of this classification system is attached to this report.

## Laboratory Testing

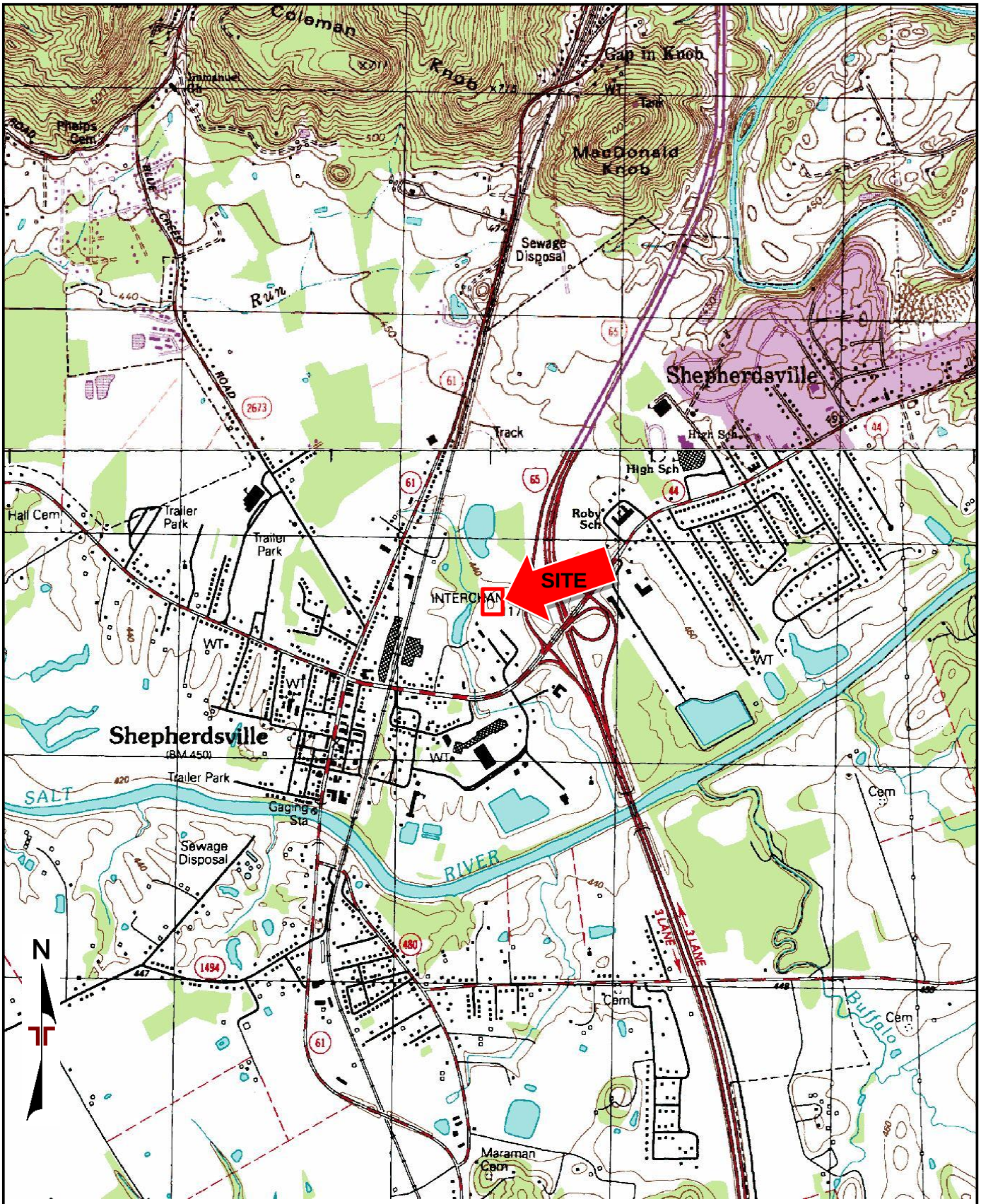
The project engineer reviews the field data and assigns various laboratory tests to better understand the engineering properties of the various soil and rock strata as necessary for this project. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods are applied because of local practice or professional judgment. Standards noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

The laboratory testing program often includes examination of soil samples by an engineer. Based on the material's texture and plasticity, we describe and classify the soil samples in accordance with the Unified Soil Classification System.

Bedrock samples were obtained, rock classification is conducted using locally accepted practices for engineering purposes; petrographic analysis may reveal other rock types. Rock core samples typically provide an improved specimen for this classification. Boring log rock classification is determined using the Description of Rock Properties and is attached to this report.

# SITE LOCATION AND EXPLORATION PLANS




TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY
QUADRANGLES INCLUDE: BROOKS, KY (1/1/1997) and SHEPHERDSVILLE, KY (1/1/1998).

| | | | |
|---|---|---|---|
| Project Manager: JDS | Project No. 57185047 | Terracon | SITE LOCATION |
| Drawn by: JDS | Scale: 1"=2,000' | 13050 Eastgate Park Way Ste 101 | Panda Express S8-19-D6462 |
| Checked by: BWT | File Name: EX. A-1 & A-2 | Louisville, KY 40223-3915 | Historical Trail Road and Conestoga Parkway |
| Approved by: BWT | Date: 5/8/2018 | | Shepherdsville, KY |

Exhibit A-1


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

| | | | | |
|---|---|---|---|---|
| Project Manager: JDS<br>Drawn by: JDS<br>Checked by: BWT<br>Approved by: BWT | Project No. 57185047<br>Scale: AS SHOWN<br>File Name: EX. A-1 & A-2<br>Date: 5/8/2018 | Terracon<br>13050 Eastgate Park Way Ste 101<br>Louisville, KY 40223-3915 | EXPLORATION PLAN<br>Panda Express S8-19-D6462<br>Historical Trail Road and Conestoga Parkway<br>Shepherdsville, KY | Exhibit<br>A-2 |

# EXPLORATION RESULTS

# BORING LOG NO. B-1



**PROJECT:** Panda Express S8-19-D6462

**CLIENT:** Panda Restaurant Group Inc
Rosemead, CA

**SITE:** Conestoga Parkeay & Historical Trail Road
Shepherdsville, KY

LOCATION See Exploration Plan

Latitude: 37.994007° Longitude: -85.708484°

Approximate Surface Elev: 444 (Ft.) +/-

| DEPTH | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In) | FIELD TEST RESULTS | LABORATORY HP (tsf) | WATER CONTENT (%) | ATTERBERG LIMITS LL-PL-PI |
|---|---|---|---|---|---|---|---|---|---|
| | **MODERATE PLASTICITY CLAY (CL)**, brown, stiff, negligible topsoil | | | | 14 | 2-2-6 N=8 | 1.5 (HP) | 23 | 47-25-22 |
| 2.0 | 442+/- | | | | | | | | |
| | **WEATHERED SHALE**, black to dark brown, fine-grained, extremely close fracture spacing, laminated bedding, completely weathered, extremely weak | | | | 14 | 9-17-50/2" | | 11 | |
| | | | | | 7 | 17-50/1" | | | |
| 5.5 | 438.5+/- | 5 | | | | | | | |
| | ***Auger Refusal at 5.5 Feet*** | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.
Elevation data from Survey Grade GPS, +/- 1ft

Hammer Type: Automatic

Advancement Method:
Solid Flight Auger

Abandonment Method:
Boring backfilled with soil cuttings after delayed water levels were measured.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

*No water observed while drilling*

*No water observed after completion of drilling*

*No water observed after 1 hr*

Terracon
13050 Eastgate Park Way Ste 101
Louisville, KY

Boring Started: 05-02-2018 | Boring Completed: 05-02-2018

Drill Rig: Hyrdofab Boremaster | Driller: J. Campbell

Project No.: 57185047

# BORING LOG NO. B-2



**PROJECT:** Panda Express S8-19-D6462

**CLIENT:** Panda Restaurant Group Inc
Rosemead, CA

**SITE:** Conestoga Parkeay & Historical Trail Road
Shepherdsville, KY

LOCATION See Exploration Plan

Latitude: 37.99407° Longitude: -85.708198°

Approximate Surface Elev: 446 (Ft.) +/-

| DEPTH | ELEVATION (Ft.) | Description | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In) | FIELD TEST RESULTS | UNCONFINED COMPRESSIVE STRENGTH (tsf) | LABORATORY HP (tsf) | WATER CONTENT (%) | ATTERBERG LIMITS LL-PL-PI |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **FILL - TOPSOIL**, 8" | | | | | | | | | |
| 0.7 | 445.5+/- | **FILL - LEAN CLAY (CL)**, with debris (i.e. asphalt fragments), brown to gray | | | | 17 | 3-4-6<br>N=10 | | 1.75<br>(HP) | 20 | 39-22-17 |
| | | - to dark brown | | | | 10 | 1-1-0<br>N=1 | | 0.5<br>(HP) | 13 | |
| 5.5 | 440.5+/- | **WEATHERED SHALE**, black to dark brown, fine-grained, very close to close fracture spacing, laminated to very thin bedding, moderately to highly weathered, extremely weak | 5 | | | 18 | 12-19-34<br>N=53 | | | 20 | |
| | | | | | | 9 | 50/4" | | | | |
| 10.2 | 436+/- | - auger refusal at 10.2' - begin coring | 10 | | | | | | | | |
| 11.5 | 434.5+/- | **SHALE**, black, fine-grained, very close to close fracture spacing, laminated to very thin bedding, slightly weathered to un-weathered, weak to medium strong, hydro-carbon odor from sample at 10.3', wash out in the upper 1'<br>- diagonal fractures at 45 degrees from 10.9' to 11.5' with slickened sides | | | | 48 | RQD=49%<br>Rec=80% | 580 | | | |
| | | **LIMESTONE**, gray, fine-grained, extremely close to moderate fracture spacing, thin bedding, slightly to moderately weathered, strong rock | | | | | | | | | |
| | | - vuggy from 14.0' to 15.0'; sample tested from 14.0 to 14.4' | | | | | | | | | |
| 15.2 | 431+/- | | 15 | | | | | | | | |
| | | ***Boring Terminated at 15.2 Feet*** | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.
Elevation data from Survey Grade GPS, +/- 1ft

Hammer Type: Automatic

Advancement Method:
Solid Flight Auger

Abandonment Method:
Boring backfilled with soil cuttings after delayed water levels were measured.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

- *On Spoon*
- *Before coring*
- *After 8 hrs*

Terracon
13050 Eastgate Park Way Ste 101
Louisville, KY

Boring Started: 05-02-2018 | Boring Completed: 05-02-2018

Drill Rig: Hyrdofab Boremaster | Driller: J. Campbell

Project No.: 57185047

# BORING LOG NO. P-1



**PROJECT:** Panda Express S8-19-D6462

**CLIENT:** Panda Restaurant Group Inc
Rosemead, CA

**SITE:** Conestoga Parkeay & Historical Trail Road
Shepherdsville, KY

LOCATION See Exploration Plan

Latitude: 37.993911° Longitude: -85.708631°

Approximate Surface Elev: 445.4 (Ft.) +/-

| DEPTH | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In) | FIELD TEST RESULTS | LABORATORY HP (tsf) | WATER CONTENT (%) | ATTERBERG LIMITS LL-PL-PI |
|---|---|---|---|---|---|---|---|---|---|
| | **TOPSOIL**, 12" | | | | | | | | |
| 1.0 | 444.5+/- | | | | 15 | 2-2-3 N=5 | 1.0 (HP) | 23 | |
| | **LEAN CLAY (CL)**, brown to gray, medium stiff to stiff | | | | | | | | |
| | - HP in the upper portion of the sample | | | | 14 | 7-14-25 N=39 | 3.5 (HP) | 17 | 38-24-14 |
| 2.5 | 443+/- | | | | | | | | |
| | **WEATHERED SHALE**, black to dark brown, fine-grained, extremely close fracture spacing, laminated bedding, completely weathered, extremely weak | | | | | | | | |
| | | | | | | 50/5" | | | |
| 4.0 | 441.5+/- | | | | | | | | |
| | ***Auger Refusal at 4 Feet*** | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.
Elevation data from Survey Grade GPS, +/- 1ft

Hammer Type: Automatic

Advancement Method:
Solid Flight Auger

Abandonment Method:
Boring backfilled with soil cuttings after delayed water levels were measured.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

*No water observed while drilling*

*No water observed after completion of drilling*

*No water observed after 1.5 hrs*

Terracon
13050 Eastgate Park Way Ste 101
Louisville, KY

Boring Started: 05-02-2018 | Boring Completed: 05-02-2018

Drill Rig: Hyrdofab Boremaster | Driller: J. Campbell

Project No.: 57185047

# BORING LOG NO. P-2



**PROJECT:** Panda Express S8-19-D6462

**CLIENT:** Panda Restaurant Group Inc
Rosemead, CA

**SITE:** Conestoga Parkeay & Historical Trail Road
Shepherdsville, KY

LOCATION See Exploration Plan

Latitude: 37.993862° Longitude: -85.708406°

Approximate Surface Elev: 441.4 (Ft.) +/-

| GRAPHIC LOG | DEPTH | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In) | FIELD TEST RESULTS | LABORATORY HP (tsf) | WATER CONTENT (%) | ATTERBERG LIMITS LL-PL-PI |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0.2 | 441+/- | | | | 2 | 50/2" | | | |

**WEATHERED SHALE**, black to dark brown, fine-grained, extremely close fracture spacing, laminated bedding, completely weathered, extremely weak, negligible topsoil

***Spoon Refusal at 0.2 Foot***

Stratification lines are approximate. In-situ, the transition may be gradual.
Elevation data from Survey Grade GPS, +/- 1ft

Hammer Type: Automatic

Advancement Method:
Solid Flight Auger

Abandonment Method:
Boring backfilled with soil cuttings after delayed water levels were measured.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

*No water observed while drilling*

*No water observed after completion of drilling*

*No water observed after 1 hr*

Terracon
13050 Eastgate Park Way Ste 101
Louisville, KY

Boring Started: 05-02-2018 | Boring Completed: 05-02-2018

Drill Rig: Hyrdofab Boremaster | Driller: J. Campbell

Project No.: 57185047

# BORING LOG NO. P-3



**PROJECT:** Panda Express S8-19-D6462

**CLIENT:** Panda Restaurant Group Inc
Rosemead, CA

**SITE:** Conestoga Parkeay & Historical Trail Road
Shepherdsville, KY

LOCATION See Exploration Plan

Latitude: 37.993787° Longitude: -85.708132°

Approximate Surface Elev: 442 (Ft.) +/-

| DEPTH | ELEVATION (Ft.) | Description |
|---|---|---|
| 0.8 | 441.5+/- | **TOPSOIL**, 9" |
| 1.5 | 440.5+/- | **LEAN CLAY (CL)**, with shale fragments |
| 2.0 | 440+/- | **WEATHERED SHALE**, black to dark brown, fine-grained, extremely close fracture spacing, laminated bedding, completely weathered, extremely weak |
| | | ***Auger Refusal at 2 Feet*** |

| DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In) | FIELD TEST RESULTS | LABORATORY HP (tsf) | WATER CONTENT (%) | ATTERBERG LIMITS LL-PL-PI |
|---|---|---|---|---|---|---|---|
| | ▼ | | 15 | 1-1-11 N=12 | | 26 | |
| | ▽ | | | 50/4" | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.
Elevation data from Survey Grade GPS, +/- 1ft

Hammer Type: Automatic

Advancement Method:
Solid Flight Auger

Abandonment Method:
Boring backfilled with soil cuttings after delayed water levels were measured.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

▽ *top of sample wet at 1.5'*

▼ *After 2.5 hrs*

Terracon
13050 Eastgate Park Way Ste 101
Louisville, KY

Boring Started: 05-02-2018 | Boring Completed: 05-02-2018

Drill Rig: Hyrdofab Boremaster | Driller: J. Campbell

Project No.: 57185047

# BORING LOG NO. P-4



**PROJECT:** Panda Express S8-19-D6462

**CLIENT:** Panda Restaurant Group Inc
Rosemead, CA

**SITE:** Conestoga Parkeay & Historical Trail Road
Shepherdsville, KY

LOCATION See Exploration Plan

Latitude: 37.993948° Longitude: -85.708235°

Approximate Surface Elev: 441.7 (Ft.) +/-

| GRAPHIC LOG | DEPTH | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In) | FIELD TEST RESULTS | LABORATORY HP (tsf) | WATER CONTENT (%) | ATTERBERG LIMITS LL-PL-PI |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **WEATHERED SHALE**, black to dark brown, fine-grained, extremely close fracture spacing, laminated bedding, completely weathered, extremely weak, negligible topsoil | | ▽ | X | 12 | 7-12-50/5" | | | |
| | 1.5 | 440+/- | | | | | | | | |
| | | ***Auger Refusal at 1.5 Feet*** | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.
Elevation data from Survey Grade GPS, +/- 1ft

Hammer Type: Automatic

Advancement Method:
Solid Flight Auger

Abandonment Method:
Boring backfilled with soil cuttings after delayed water levels were measured.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

▽ *While drilling*

▽ *At completion of drilling*

*No water observed after 3 hrs*

Terracon
13050 Eastgate Park Way Ste 101
Louisville, KY

Boring Started: 05-02-2018 | Boring Completed: 05-02-2018

Drill Rig: Hyrdofab Boremaster | Driller: J. Campbell

Project No.: 57185047

# BORING LOG NO. P-5



**PROJECT:** Panda Express S8-19-D6462

**CLIENT:** Panda Restaurant Group Inc
Rosemead, CA

**SITE:** Conestoga Parkeay & Historical Trail Road
Shepherdsville, KY

LOCATION See Exploration Plan

Latitude: 37.994018° Longitude: -85.708135°

Approximate Surface Elev: 446 (Ft.) +/-

| DEPTH | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In) | FIELD TEST RESULTS | LABORATORY HP (tsf) | WATER CONTENT (%) | ATTERBERG LIMITS LL-PL-PI |
|---|---|---|---|---|---|---|---|---|---|
| **FILL - TOPSOIL**, 8" | | | | | | | | | |
| 0.7 | 445.5+/- | | | | | | | | |
| **FILL - MODERATE PLASTICITY CLAY (CL)**, with shale fragments, light brown with brown | | | | | | | | | |
| | | | | | 12 | 2-3-4<br>N=7 | | 17 | |
| - transition to gray, with hydro-carbon odor & shale fragments | | | | | | | | | |
| | | | | | 18 | 3-3-4<br>N=7 | 1.5<br>(HP) | 23 | 41-23-18 |
| 6.0 | 440+/- | 5 | | | | | | | |
| **WEATHERED SHALE**, black to dark brown, fine-grained, extremely close fracture spacing, laminated bedding, highly to completely weathered, extremely weak | | | ▼ | | 16 | 4-5-21<br>N=26 | | 20 | |
| 8.0 | 438+/- | | | | | | | | |
| ***Auger Refusal at 8 Feet*** | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.
Elevation data from Survey Grade GPS, +/- 1ft

Hammer Type: Automatic

Advancement Method:
Solid Flight Auger

Abandonment Method:
Boring backfilled with soil cuttings after delayed water levels were measured.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

*No water observed while drilling*

▼ *At completion of drilling*

Terracon
13050 Eastgate Park Way Ste 101
Louisville, KY

Boring Started: 05-02-2018 | Boring Completed: 05-02-2018

Drill Rig: Hyrdofab Boremaster | Driller: J. Campbell

Project No.: 57185047

# BORING LOG NO. P-6



**PROJECT:** Panda Express S8-19-D6462

**CLIENT:** Panda Restaurant Group Inc
Rosemead, CA

**SITE:** Conestoga Parkeay & Historical Trail Road
Shepherdsville, KY

LOCATION See Exploration Plan

Latitude: 37.994152° Longitude: -85.708475°

Approximate Surface Elev: 441.5 (Ft.) +/-

| DEPTH | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In) | FIELD TEST RESULTS | LABORATORY HP (tsf) | WATER CONTENT (%) | ATTERBERG LIMITS LL-PL-PI |
|---|---|---|---|---|---|---|---|---|---|
| **FILL - LEAN CLAY (CL)**, with shale fragments, brown | | | | | | | | | |
| 1.5 | 440+/- | | | | 5 | 4-1-4<br>N=5 | | 14 | |
| **WEATHERED SHALE**, black to dark brown, fine-grained, extremely close fracture spacing, laminated bedding, highly to completely weathered, extremely weak | | | | | 5 | 7-19-50/2" | | 13 | |
| 3.5 | 438+/- | | | | | | | | |
| ***Auger Refusal at 3.5 Feet*** | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.
Elevation data from Survey Grade GPS, +/- 1ft

Hammer Type: Automatic

Advancement Method:
Solid Flight Auger

Abandonment Method:
Boring backfilled with soil cuttings after delayed water levels were measured.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

*No water observed while drilling*

*No water observed after completion of drilling*

*No water observed after 2.5 hrs*

Terracon
13050 Eastgate Park Way Ste 101
Louisville, KY

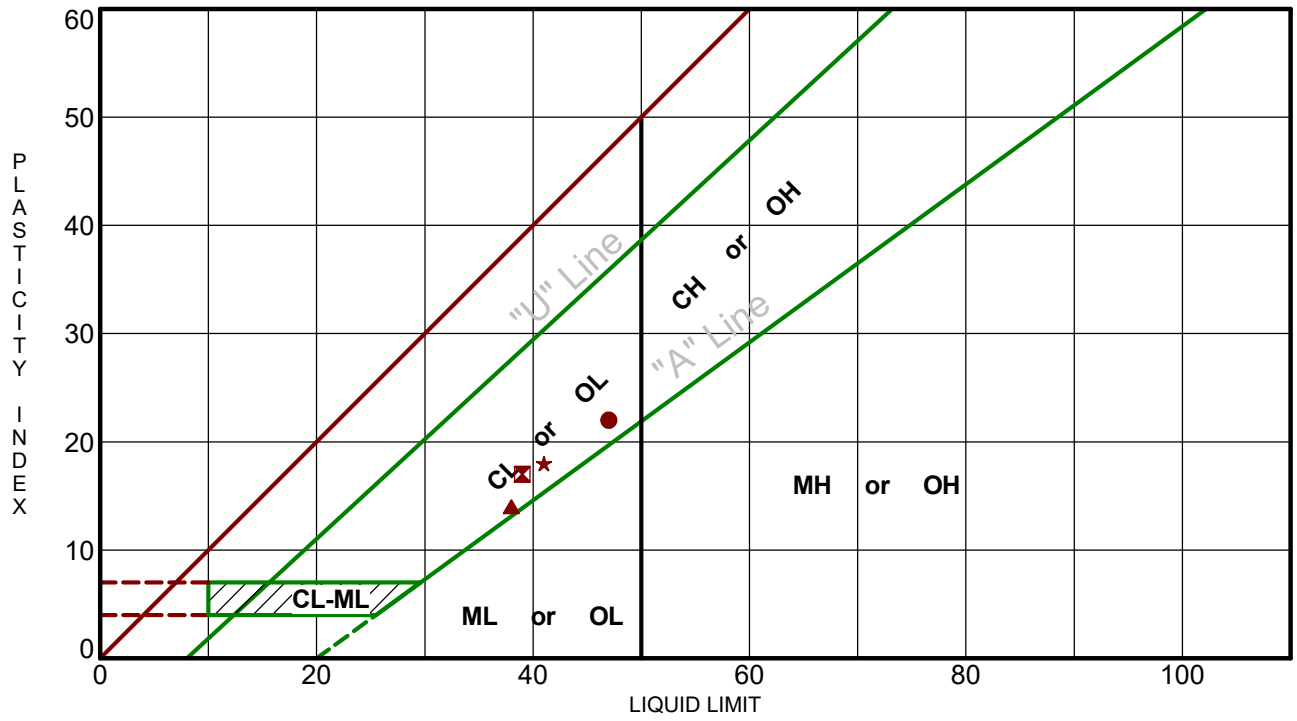
Boring Started: 05-02-2018 | Boring Completed: 05-02-2018

Drill Rig: Hyrdofab Boremaster | Driller: J. Campbell

Project No.: 57185047

# ATTERBERG LIMITS RESULTS

**ASTM D4318**




| Boring ID | | Depth | LL | PL | PI | Fines | USCS | Description |
|---|---|---|---|---|---|---|---|---|
| ● | B-1 | 0 - 1.5 | 47 | 25 | 22 | | CL | MODERATE PLASTICITY CLAY |
| ⊠ | B-2 | 1 - 2.5 | 39 | 22 | 17 | | CL | LEAN CLAY |
| ▲ | P-1 | 1.5 - 3 | 38 | 24 | 14 | | CL | LEAN CLAY |
| ★ | P-5 | 3.5 - 5 | 41 | 23 | 18 | | CL | MODERATE PLASTICITY CLAY |

PROJECT: Panda Express S8-19-D6462

SITE: Conestoga Parkeay & Historical Trail Road
Shepherdsville, KY

Terracon
13050 Eastgate Park Way Ste 101
Louisville, KY

PROJECT NUMBER: 57185047

CLIENT: Panda Restaurant Group Inc
Rosemead, CA

# PHOTOGRAPHY LOG


2018-05-02 07.17.24: Drainage swale located south of B-2.

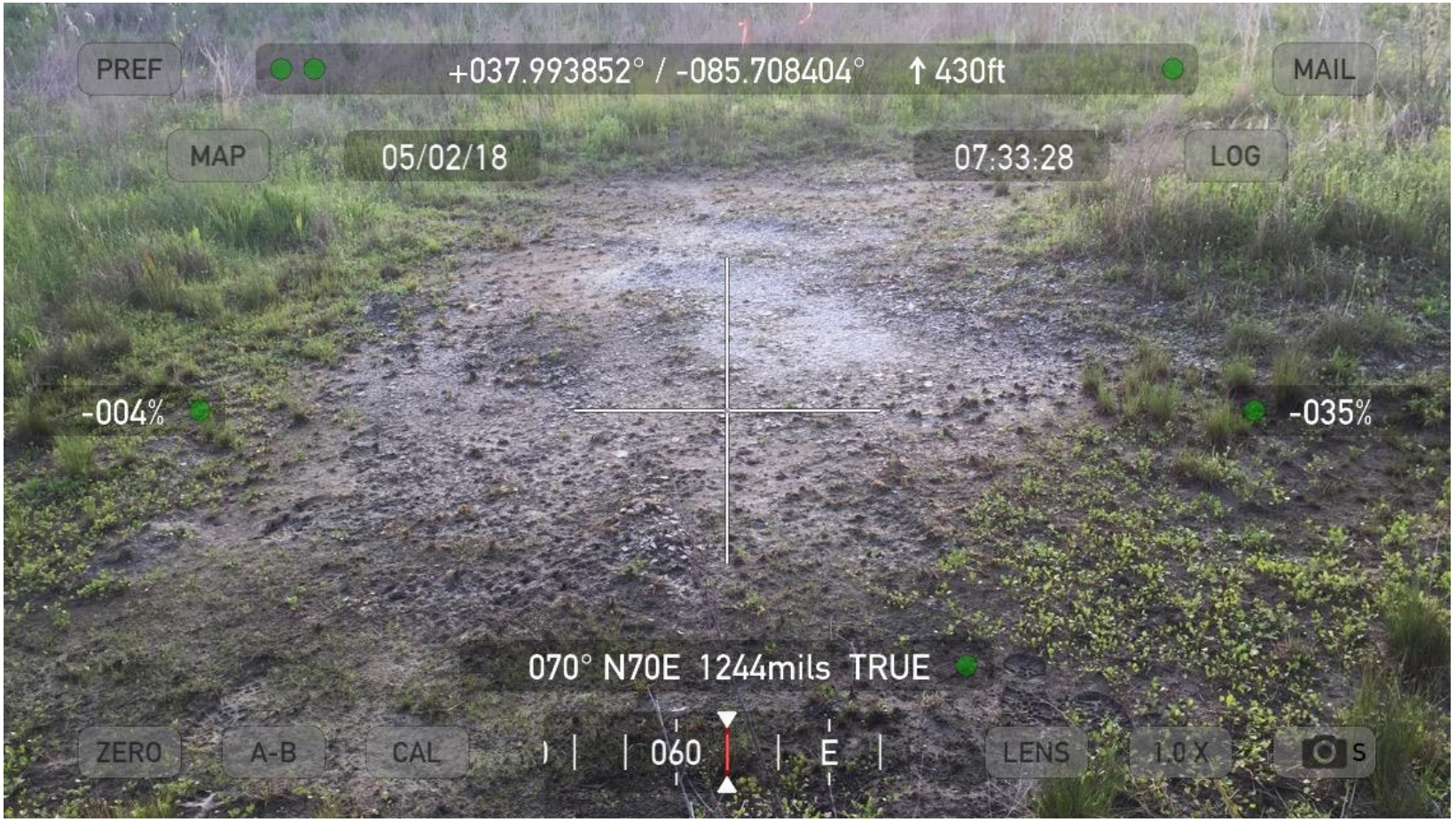
Note: Horizontal and vertical datum from mobile device for general orientation/location purposes only and is not intended for construction.


2018-05-02 07.30.48: View from P-3.

Note: Horizontal and vertical datum from mobile device for general orientation/location purposes only and is not intended for construction.


2018-05-02 10.31.32: Exposed highly weathered shale near P-4 on the south side of the drainage swale located within the proposed building's footprint.

Note: Horizontal and vertical datum from mobile device for general orientation/location purposes only and is not intended for construction.




2018-05-02 07.33.29: Exposed highly weathered shale at the bottom of the borrow site near P-2 and P-4.

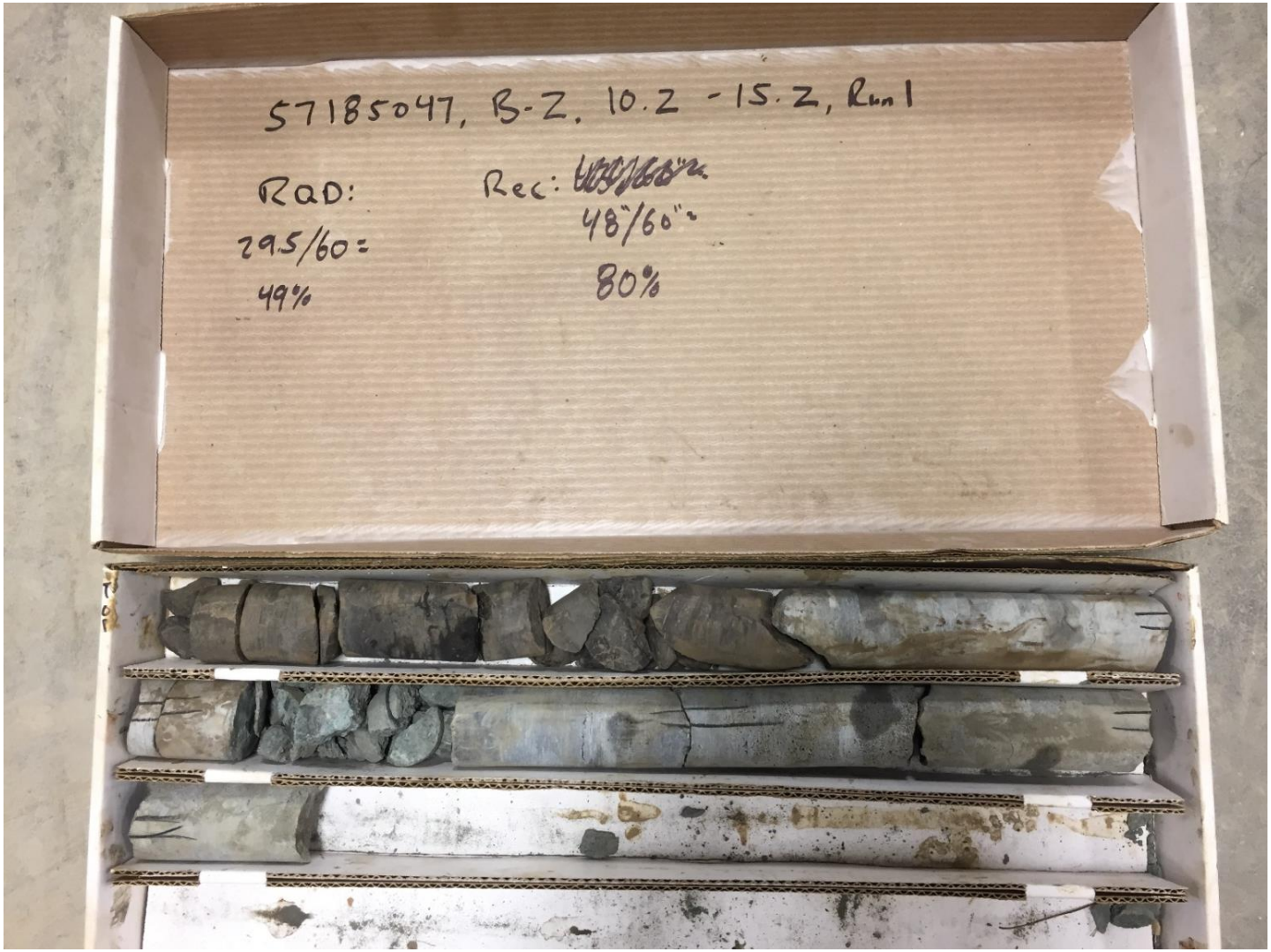
Note: Horizontal and vertical datum from mobile device for general orientation/location purposes only and is not intended for construction.


2018-05-02 10.34.47: Highly weathered shale exposed at the bottom of the borrow site near P-2.

Note: Horizontal and vertical datum from mobile device for general orientation/location purposes only and is not intended for construction.


2018-05-02 10.40.02: Rubble stockpiles located south-east of the proposed Panda Express.

Note: Horizontal and vertical datum from mobile device for general orientation/location purposes only and is not intended for construction.




2018-05-03 09.44.49: 5-foot rock core from B-2.

Note: Horizontal and vertical datum from mobile device for general orientation/location purposes only and is not intended for construction.


2018-05-02 07.15.18: Marked gas line and communication line on the south side of Historical Trail Road near B-2 and P-5.

Note: Horizontal and vertical datum from mobile device for general orientation/location purposes only and is not intended for construction.


2018-05-02 07.36.27: Marked gas line and communication line on the east side of Conestoga Parkway.

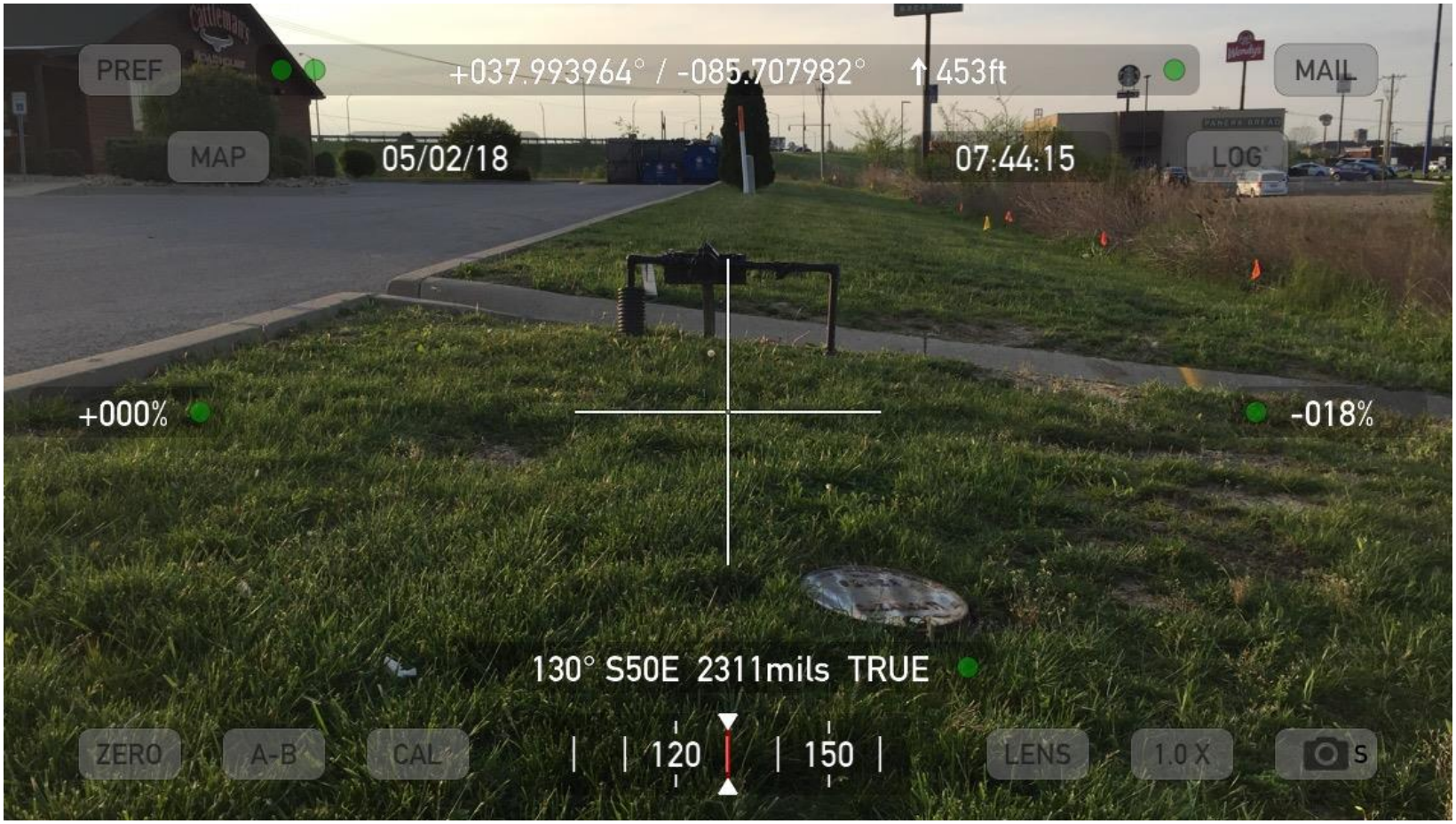
Note: Horizontal and vertical datum from mobile device for general orientation/location purposes only and is not intended for construction.


2018-05-02 07.37.52: Utility marker at the intersection of Conestoga Parkway and Historical Trail Road.

Note: Horizontal and vertical datum from mobile device for general orientation/location purposes only and is not intended for construction.


2018-05-02 07.38.04: Utility markers at the intersection of Conestoga Parkway and Historical Trail Road.

Note: Horizontal and vertical datum from mobile device for general orientation/location purposes only and is not intended for construction.




2018-05-02 07.44.15: Utility markers located east of P-5.

Note: Horizontal and vertical datum from mobile device for general orientation/location purposes only and is not intended for construction.

# SUPPORTING INFORMATION

# UNIFIED SOIL CLASSIFICATION SYSTEM

Panda Express S8-19-D6462 ■ Shepherdsville, Bullitt County, Kentucky

May 31, 2018 ■ Terracon Project No. 57185047

| Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A] | | | | | Soil Classification | |
|---|---|---|---|---|---|---|
| | | | | | Group Symbol | Group Name [B] |
| **Coarse-Grained Soils:** More than 50% retained on No. 200 sieve | **Gravels:** More than 50% of coarse fraction retained on No. 4 sieve | **Clean Gravels:** Less than 5% fines [C] | Cu ≥ 4 and 1 ≤ Cc ≤ 3 [E] | | GW | Well-graded gravel [F] |
| | | | Cu < 4 and/or 1 > Cc > 3 [E] | | GP | Poorly graded gravel [F] |
| | | **Gravels with Fines:** More than 12% fines [C] | Fines classify as ML or MH | | GM | Silty gravel [F, G, H] |
| | | | Fines classify as CL or CH | | GC | Clayey gravel [F, G, H] |
| | **Sands:** 50% or more of coarse fraction passes No. 4 sieve | **Clean Sands:** Less than 5% fines [D] | Cu ≥ 6 and 1 ≤ Cc ≤ 3 [E] | | SW | Well-graded sand [I] |
| | | | Cu < 6 and/or 1 > Cc > 3 [E] | | SP | Poorly graded sand [I] |
| | | **Sands with Fines:** More than 12% fines [D] | Fines classify as ML or MH | | SM | Silty sand [G, H, I] |
| | | | Fines classify as CL or CH | | SC | Clayey sand [G, H, I] |
| **Fine-Grained Soils:** 50% or more passes the No. 200 sieve | **Silts and Clays:** Liquid limit less than 50 | **Inorganic:** | PI > 7 and plots on or above "A" | | CL | Lean clay [K, L, M] |
| | | | PI < 4 or plots below "A" line [J] | | ML | Silt [K, L, M] |
| | | **Organic:** | Liquid limit - oven dried / Liquid limit - not dried | < 0.75 | OL | Organic clay [K, L, M, N] / Organic silt [K, L, M, O] |
| | **Silts and Clays:** Liquid limit 50 or more | **Inorganic:** | PI plots on or above "A" line | | CH | Fat clay [K, L, M] |
| | | | PI plots below "A" line | | MH | Elastic Silt [K, L, M] |
| | | **Organic:** | Liquid limit - oven dried / Liquid limit - not dried | < 0.75 | OH | Organic clay [K, L, M, P] / Organic silt [K, L, M, Q] |
| **Highly organic soils:** | Primarily organic matter, dark in color, and organic odor | | | | PT | Peat |

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

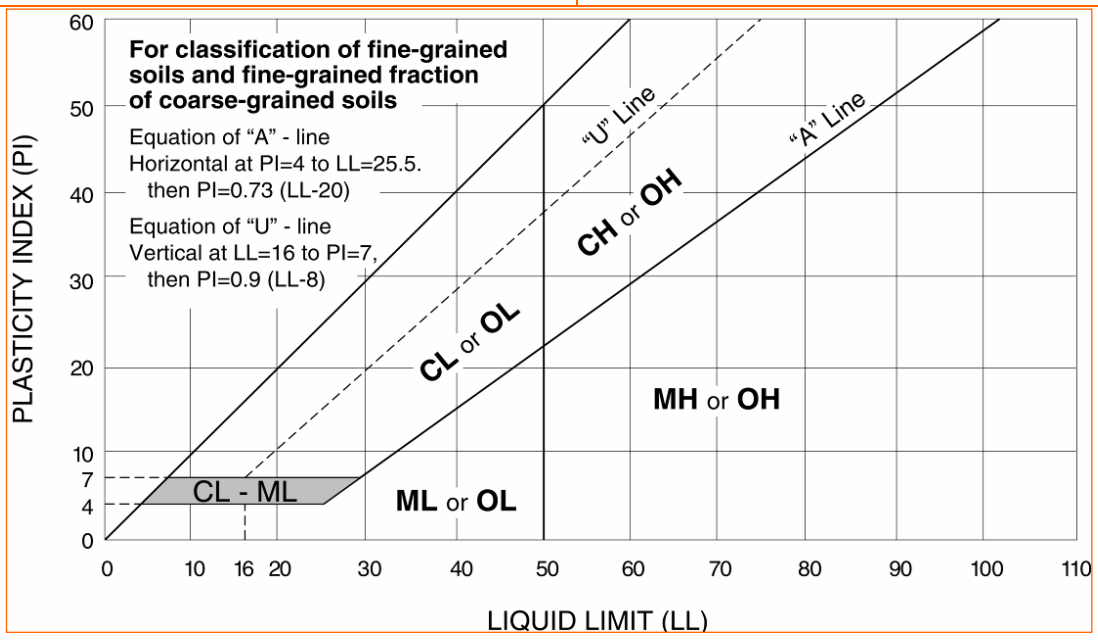
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



# DESCRIPTION OF ROCK PROPERTIES

Panda Express S8-19-D6462 ■ Shepherdsville, Bullitt County, Kentucky

May 31, 2018 ■ Terracon Project No. 57185047

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

| STRENGTH OR HARDNESS | | |
|---|---|---|
| **Description** | **Field Identification** | **Uniaxial Compressive Strength, psi (MPa)** |
| **Extremely weak** | Indented by thumbnail | 40-150 (0.3-1) |
| **Very weak** | Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife | 150-700 (1-5) |
| **Weak rock** | Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer | 700-4,000 (5-30) |
| **Medium strong** | Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer | 4,000-7,000 (30-50) |
| **Strong rock** | Specimen requires more than one blow of geological hammer to fracture it | 7,000-15,000 (50-100) |
| **Very strong** | Specimen requires many blows of geological hammer to fracture it | 15,000-36,000 (100-250) |
| **Extremely strong** | Specimen can only be chipped with geological hammer | >36,000 (>250) |

| DISCONTINUITY DESCRIPTION | | | |
|---|---|---|---|
| **Fracture Spacing (Joints, Faults, Other Fractures)** | | **Bedding Spacing (May Include Foliation or Banding)** | |
| **Description** | **Spacing** | **Description** | **Spacing** |
| **Extremely close** | < ¾ in (<19 mm) | **Laminated** | < ½ in (<12 mm) |
| **Very close** | ¾ in – 2-1/2 in (19 - 60 mm) | **Very thin** | ½ in – 2 in (12 – 50 mm) |
| **Close** | 2-1/2 in – 8 in (60 – 200 mm) | **Thin** | 2 in – 1 ft. (50 – 300 mm) |
| **Moderate** | 8 in – 2 ft. (200 – 600 mm) | **Medium** | 1 ft. – 3 ft. (300 – 900 mm) |
| **Wide** | 2 ft. – 6 ft. (600 mm – 2.0 m) | **Thick** | 3 ft. – 10 ft. (900 mm – 3 m) |
| **Very Wide** | 6 ft. – 20 ft. (2.0 – 6 m) | **Massive** | > 10 ft. (3 m) |

Discontinuity Orientation (Angle): Measure the angle of discontinuity relative to a plane perpendicular to the longitudinal axis of the core. (For most cases, the core axis is vertical; therefore, the plane perpendicular to the core axis is horizontal.) For example, a horizontal bedding plane would have a 0-degree angle.

| ROCK QUALITY DESIGNATION (RQD) [1] | |
|---|---|
| **Description** | **RQD Value (%)** |
| **Very Poor** | 0 - 25 |
| **Poor** | 25 – 50 |
| **Fair** | 50 – 75 |
| **Good** | 75 – 90 |
| **Excellent** | 90 - 100 |

1. The combined length of all sound and intact core segments equal to or greater than 4 inches in length, expressed as a percentage of the total core run length.

Reference: U.S. Department of Transportation, Federal Highway Administration, Publication No FHWA-NHI-10-034, December 2009 Technical Manual for Design and Construction of Road Tunnels – Civil Elements