Geotechnical Engineering Report

Proposed Taco Bell Restaurant

Wheeling, West Virginia

February 4, 2016

Terracon Project No. N2165027

Prepared for:

Charter Foods, Inc.
Talbott, Tennessee

Prepared by:

Terracon Consultants, Inc.
Charleston, West Virginia

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Terracon

February 4, 2016

Charter Foods, Inc.
P.O. Box 430
Talbott, Tennessee 37877

Attn: Mr. Bob Rave
P: [423] 254-5553
E: brave@charterfoods.net

Re: Geotechnical Engineering Report
Proposed Taco Bell Restaurant
Wheeling, West Virginia
Terracon Project No. N2165027

Dear Mr. Rave:

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the above referenced project. This study was performed in general accordance with Proposal PN2150300 dated and approved December 21, 2015. 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 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.

John-Paul P. Gwilliams, E.I.
Staff Geotechnical Engineer

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KEVIN M. ERNST
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STATE OF
WEST VIRGINIA
PROFESSIONAL ENGINEER

Enclosures
cc: 1 pdf – Kathleen Day, Architect
cc: 1 pdf – Above

EXECUTIVE SUMMARY

A geotechnical engineering report has been completed for the proposed Taco Bell Restaurant planned to be constructed in Wheeling, West Virginia. Four (4) building borings, designated B-3 through B-6, were performed to a depth of 21.5 feet below the existing ground surface. In addition, two pavements borings, Borings B-1 and B-2, were drilled to a depth of 10 feet. This report provides our recommendations for support of the proposed building and pavements.

The following geotechnical considerations were identified:

- Undocumented fill was encountered in the test borings to depths ranging from about 6.5 to 9 feet beneath existing grades in borings B-1, B-2, B-3, B-4, B-5, and B-6 and consisted primarily of soft to medium stiff lean clay with coal and calcareous rock fragments and loose to medium dense poorly graded gravel containing notable deleterious material such as coal, slag, and trace clay. All of the borings encountered soft to medium stiff natural cohesive soils consisting of lean clays and possible lean to fat clays to an undetermined depths. Auger refusal was not encountered in any of the six borings.

- The relative density of the fill appears to be variable (soft to medium stiff cohesive soils and loose to medium dense granular soils) based on boring information. We recommend the current owner of the site be inquired to provide testing records of fill placement and compaction (if available). Without these records the fill must be considered uncontrolled.

- We recommend complete removal of existing fill within the footprint of the proposed building structure and at least 5 feet beyond the building limits. After removal of the fill and stabilization of unstable natural soils, the site appears suitable for use of shallow foundations bearing on stiff native soils or on structural fill extending to the soft to medium stiff native soils.

- The borings indicated the possible presence of moderately high plasticity soils with the potential for shrink-swell behavior. If such soils exist and are exposed at the subgrade elevation of the floor slabs or pavements, a 12-inch thick low volume change layer should be constructed beneath proposed floor slab and pavement subgrade elevations to reduce exposure to these potentially expansive soils.

- The support of pavements over some thickness of existing fill is discussed in this report. However, even with the recommended construction testing, there is a risk that unsuitable materials within or buried by the fill will not be discovered. This risk cannot be eliminated without the removing the fill, but can be reduced through exploration and testing during construction.

- Based on the testing results, the existing fill material generally appears to be suitable for reuse. However, we recommend that test pits and laboratory testing be performed to verify the suitability of the existing fill materials for reuse as engineered fill. Additionally unsuitable materials will need to be removed from the existing fill materials as part of the criteria for reuse.

- Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support. We therefore recommend that Terracon be retained to monitor this portion of the work.

- Soils prone to shrink/swell characteristics are present on this site. This report provides recommendations to help mitigate the effects of soil shrinkage and swell. However, even if these procedures are followed, some movement and cracking in the structure should be anticipated. The severity of cracking and other damage such as uneven floor slabs may increase if any modification of the site results in excessive wetting or drying of the shrink/swell prone soils. Eliminating the risk of movement and distress may not be feasible, but it may be possible to further reduce the risk of movement if significantly more expensive measures are used during construction. We would be pleased to discuss other construction alternatives with you upon request.

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 section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

GEOTECHNICAL ENGINEERING REPORT
PROPOSED TACO BELL RESTAURANT
WHEELING, WEST VIRGINIA
Terracon Project No. N2165027
February 4, 2016

1.0 INTRODUCTION

A geotechnical engineering report has been completed for the proposed Taco Bell Restaurant planned to be constructed in Wheeling, West Virginia. Four (4) building borings, designated B-3 through B-6, were performed to a depth of 21.5 feet below the existing ground surface. In addition, two pavements borings, borings B-1 and B-2, were drilled to a depth of 11.5 feet. This report provides our recommendations for support of the proposed building and pavements. Logs of the borings along with a site location plan and a exploration plan are included in Appendix A of this report.

The purpose of this report is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- groundwater conditions
- earthwork
- foundation design and construction
- pavement design and construction

2.0 PROJECT INFORMATION

2.1 Project Description

ITEM	DESCRIPTION
Structures	Single story restaurant building
Building construction	Masonry structure (assumed)
Finished floor elevation	Unknown: assumed to be within 2± feet of the existing ground surface elevation
Maximum loads	Columns: 50 kips (assumed) Walls: 4 kips per lineal foot (assumed)
Grading	Assumed to be less than 2 feet of cut/fill
Below Grade Areas	N/A

2.2 Site Location and Description

Item	Description
Location	See Appendix A, Exhibit A-1: Site Location Plan The proposed project site is located at 770 National Road, Wheeling, West Virginia.
Existing Improvements	A Long John Silver's restaurant (currently not in operation) to be demolished.
Current Ground Cover	Asphalt pavement and concrete
Existing topography	Relatively level

3.0 SUBSURFACE CONDITIONS

3.1 Geology

A review of geologic literature indicates that the site is located within an area consisting of alluvium and deposited in present and former flood plains of the Wheeling Creek and the Ohio River. Silty and clayey soils are encountered in areas of fine grained deposits and sand and gravel in areas of shallow bedrock. The underlying and surrounding bedrock is of the Monongahela Group and consists of non-marine cyclic sequences of sandstone, siltstone, red and gray shale, limestone, and coal.

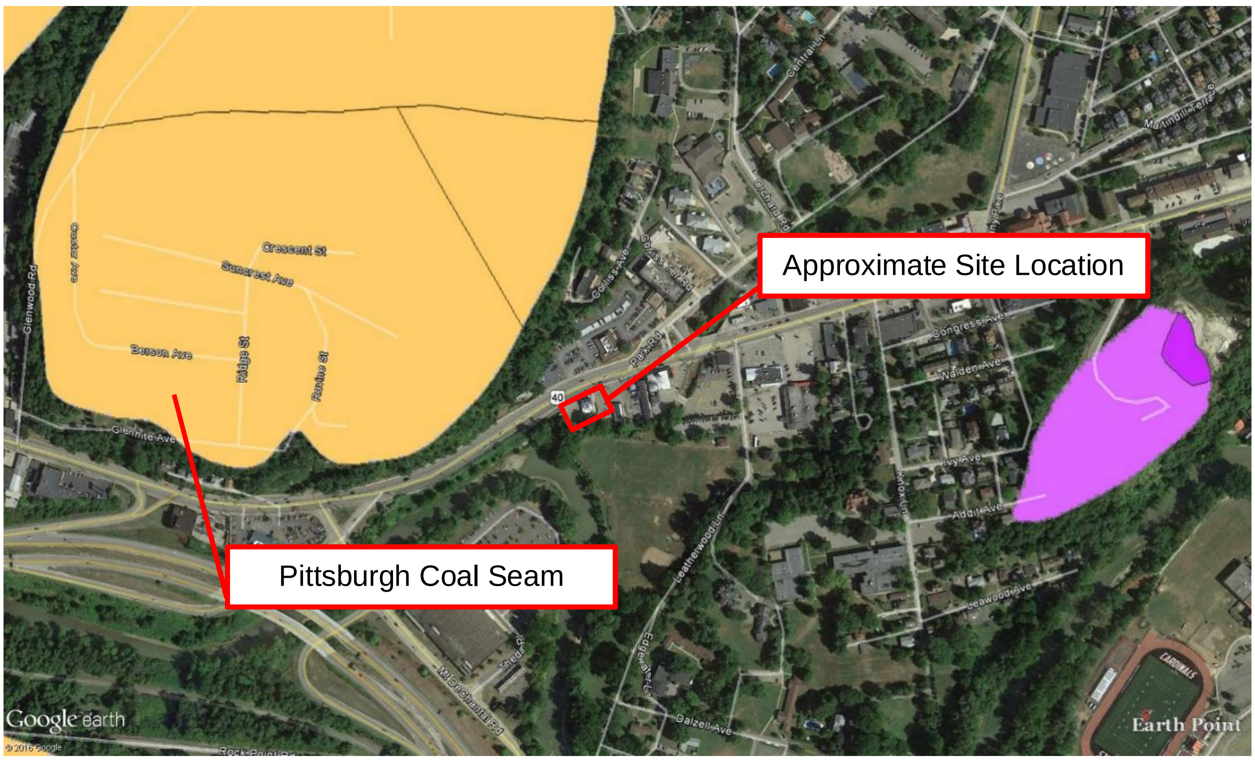
A review of the West Virginia Geologic and Economic Survey (WVGES) County Geologic Survey Report, discussion with WVGES personnel, as well as, an online review of the WVGES Interactive Coal Bed Mapping Project, indicated some underground mining in the Pittsburgh coal seam due northwest beyond the project limits. The mining identified in the WVGES mapping system indicates that the nearest mined seam in the Pittsburgh coal seam is approximately 250 to 300 feet from the project limits.

The West Virginia Geologic and Economic Survey (WVGES) maintains a database of permitted surface and underground mines spatially referenced on maps of differing scales. Maps of underground mines are sent to the WVGES upon completion of mining on the permit. Unfortunately, records are incomplete due to the limited number of years requiring permitting and mapping, and the timing and scale of some of the mining in the project area. Due to the limited records available to the WVGES, the lack of identified mines in any area of the proposed alignment does not indicate a definite "mine free" area. It is possible that the timing or scale of underground mining may not have required notification of state agencies, thus no record would be available.

According to available WVGES records, the Pittsburgh coal seam occurs at elevations well below the proposed boring locations. The Pittsburgh coal seam occurs at an elevation depth of 514 to 520 feet, well below the depths required for the scope of this project.

The elevations on the table above have been interpolated from WVGES Interactive Coal Bed Mapping resource, as well as, from structural contour maps for the coal seam. These structural contour maps have been created from coal elevation data from test borings and mapping conducted by the WVGES over the past 100 years. Due to the interpretive nature of these maps, the coal seam elevations on the table should be considered as an estimate.

Figure 1: Pittsburgh Coal Seam



3.2 Typical Profile

Conditions encountered at each boring location are indicated on the individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs in Appendix A of this report. Based on the results of the borings, subsurface conditions on the project site can be generalized as follows:

Description	Approximate Depth to Bottom of Stratum (feet)	Material Encountered	Consistency/Density/ Hardness
Surface	0.5	Asphalt or Concrete[1]	N/A
Stratum 1	6.5 to 9	Cohesive soils consisting of lean clay with variable amounts of calcareous rock fragments, coal, slag, and interbedded laminated gray shale Granular Soils consisting of poorly graded gravel with variable amounts coal, slag, and trace clay[2]	N/A – Uncontrolled Fill
Stratum 2	Undetermined depths, borings B-2, B-3, B-4, B-5, and B-6 were terminated in this layer	Lean to Fat Clay with trace amounts of coal embedded in soil matrix	soft to stiff

1. Borings B-1, B-2, B-3, and B-4 were drilled in areas of asphalt pavement. Borings B-5 and B-6 were drilled in areas of concrete pavement. Boring B-5 encountered approximately 5 feet of concrete and brick fill.
2. The layer represented as Stratum 1 consists solely of uncontrolled fill material based on the SPT value and variable amounts of deleterious material encountered in the boring logs.

3.3 Groundwater

The boreholes were observed while drilling for the presence and level of groundwater. The water levels during these times are indicated in the table below.

Boring Number	Approximate Depth to Water After Drilling (feet)
B-1	N/E
B-2	8.5
B-3	14.8
B-4	15.1
B-5	15.3
B-6	15.2

N/E – Not Encountered

The absence of observed water in some of the borings does not necessarily mean that the boring terminated above groundwater. A relatively long period of time 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.

Groundwater level fluctuations should be expected to occur due to seasonal variations in rainfall, runoff and other factors such as the water level of the nearby Wheeling Creek not evident at the time the test 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 attached test boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

Undocumented fill was encountered in all six (6) test borings at depths ranging from 6.5 to 9 feet. The fill appeared to primarily consist of loose to medium dense poorly graded gravel with coal, slag, and trace clay and soft to medium stiff lean clays with variable amounts of calcareous rock fragments, coal, and slag. Additionally, approximate 5 feet of concrete and brick fill were encountered in Boring B-5. Natural soils consisting of soft to stiff lean clay and lean to fat clay were encountered below the fill in all of the borings. Auger refusal was not encountered in any of the test borings, and the borings were terminated at a depth ranging from 11.5 to 21.5 feet below the ground surface.

Undocumented fill poses a risk for site development due to its variability and potential to contain unsuitable/highly compressible materials. The relative density and consistency of the fill appears to be variable (loose to medium dense and soft to medium stiff) based on boring information. We recommend that the current owner of the site be inquired to provide testing records of fill placement and compaction (if available). Without these records the fill is considered uncontrolled.

With uncontrolled fill there is an inherent risk for the owner that compressible fill or unsuitable material within or buried by the fill will not be discovered. The risk of unforeseen circumstances cannot be eliminated without completely removing the existing fill. We recommend complete removal of all of the existing fill within the footprint of the proposed building structure and at least 5 feet beyond the building limits. Once the fill is removed and unstable natural soils are remediated/stabilized, the site appears suitable for use of shallow foundations. The foundations should bear directly on stiff natural soils or on structural fill extending to stiff/medium dense natural soils.

Some of the borings indicated the possible presence of moderately high plasticity soils such as lean to fat clays. Lean to fat clays have liquid limits greater than 40 and can experience shrink/swell behavior due to fluctuations in moisture conditions. If such materials are exposed at pavement or floor slab subgrade elevation, a low volume change layer of structural fill material should be created beneath these floor slab and pavement areas to reduce the potential for shrink/swell behavior from cracking distress to the floor slab. This low volume change layer should consist of a minimum of 12 inches of low volume change structural fill material. Tests should be performed during construction to confirm that the fill used to construct this layer does not contain unsuitable materials. The top 12 inches of the new fill in the building and pavement areas should also consist of low volume change material. The low volume change layer could also consist of a 12-inch thick layer of lime stabilizing moderate to high plasticity soils. The lime reduces the plasticity of these soils and the associated shrink/swell potential.

The support of pavements over some thickness of existing fill is discussed in this report. However, even with the recommended construction testing, there is a risk that unsuitable materials within or buried by the fill will not be discovered. This risk cannot be eliminated without the removing of all fill, but can be reduced through exploration and testing during construction.

Soils prone to shrink/swell characteristics are present on this site. This report provides recommendations to help mitigate the effects of soil shrinkage and swell. However, even if these procedures are followed, some movement and cracking in the structure should be anticipated. The severity of cracking and other damage such as uneven floor slabs may increase if any modification of the site results in excessive wetting or drying of the shrink/swell prone soils. Eliminating the risk of movement and distress may not be feasible, but it may be possible to further reduce the risk of movement if significantly more extensive measures are used during construction. We would be pleased to discuss other construction alternatives with you upon request.

Based on the test boring results, the existing fill material appears to be suitable for reuse. However, we recommend that test pits and laboratory testing be performed to verify the suitability of existing fill material for reuse as engineered fill.

Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support. We therefore recommend that Terracon be retained to monitor this portion of the work.

In the following paragraphs we have provided our geotechnical recommendations:

4.2 Site Preparation and Earthwork

It is assumed that the site will involve removal and replacement of existing asphalt pavements. Site preparation in structural areas and areas to receive structural fill should commence with stripping of the existing asphalt pavement and gravel base and any topsoil or otherwise unsuitable materials which may be encountered. The actual removal depths will vary and should be evaluated by a Terracon representative during construction.

4.2.1 Site Preparation Recommendations

Removal and/or relocation of any "to be abandoned" utilities, foundations, floor slabs, etc. associated with the existing Long John Silver Restaurant building that will be demolished should be performed prior to rough site grading activities. We would anticipate removal and relocation, or re-routing, of any existing utilities which currently exist within the footprint of the proposed development area that would interfere with new construction. Any abandoned underground pipes, left in place, should be fully grouted. Excavations created due to foundation, floor slab, utility relocations or field tile removal should be backfilled with structural fill material, placed and compacted in accordance with the recommendations provided in the following paragraphs or with lean concrete or flowable fill. If lean concrete is used as backfill, the contractor should refer to all of the new build Mechanical-Electrical-Plumbing (MEP) and foundation drawings to confirm that the concrete backfill materials will not conflict with any new item installations or construction.

Following stripping/removal of topsoil, fill and unsuitable native materials (soft clays, etc.) and after performing any required cutting to establish the proposed subgrade elevations or undercutting unsuitable materials, all structural areas should be carefully proof rolled under close observation by geotechnical personnel. This proof rolling program is very important with respect to evaluating structural fill, floor slab and pavement support areas. Proof rolling should be accomplished using a pneumatic-tired fully loaded minimum 20 ton tandem-axle dump truck. Soft or yielding areas should be undercut or stabilized. The proof rolling program should consist of a minimum of 3 passes by the proof rolling equipment. It may not be practical to proof roll soft native material at the bottom of the undercut for the building structure. The stabilization and suitability of this subgrade is recommended to receive structural backfill and should be monitored by a representative of the Geotechnical Engineer.

Based on the boring information, undercut of about 6.5 to 9 feet of existing fill is recommended in the proposed building footprint and 5 feet beyond the building limits. A partial undercut of 2 feet of the fill should be undertaken in the proposed parking areas to provide a uniform subgrade for pavements. However, actual undercut depths should be determined based on the results of the proofrolling and testing during construction. If groundwater is encountered during the undercutting process, measures should be implemented to control it during and after construction. The soft native soils below the fill will likely need to be stabilized with stone or other means to allow for placement and compaction of structural backfill.

The top 12 inches of the finished subgrade in the building and pavement areas should consist of low volume change material which is free of shrink/swell prone materials such as highly plastic soils. If these soils are encountered at subgrade elevation, they should be undercut and replaced with low volume change material. The low volume change layer can also consist of 12-inch thick layer of lime stabilized moderate to high plasticity soils.

After undercutting, proof rolling stabilization (if necessary), and approval of geotechnical personnel, structural fill meeting the requirements of Section 4.2.2 – Structural Fill Material

Requirements, should be placed and compacted to meet the requirements of the Section 4.2.3 – Structural Fill Compaction Requirements.

4.2.2 Structural Fill Material Requirements

All material to be used as engineered fill must be tested in the laboratory to determine its suitability and compaction characteristics. Materials used for structural fill should have a maximum particle size of 3 inches.

Structural fill should meet the following material property requirements:

Fill Type [1]	USCS Classification	Acceptable Location for Placement
Lean clay (low volume change material)	CL (LL<40)	All locations and elevations
Lean to fat clay and fat clays	CL/CH (40<LL<50) CH (LL>50)	>12 inches below building finished grade
Well graded granular (low volume change material)	GW, GM [2]	All locations and elevations
Existing fill materials / native on site soils	GC-GM, CL	Appear to be suitable for reuse as structural fill based on collected samples, however this should be confirmed by performing laboratory testing. However, debris, construction rubble, and deleterious material should be removed from the fill.

1. Compacted structural fill should consist of approved materials that are 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.
2. Similar to crushed limestone aggregate. If frost heave is not a concern, limestone screenings or granular material such as sand, gravel or crushed stone may also be used. Material should be approved by the geotechnical engineer.

4.2.3 Structural Fill Compaction Requirements

Item	Description
Fill Lift Thickness	9-inches or less in loose thickness when heavy, self-propelled compaction equipment is used. 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used.
Minimum Compaction Requirement [1, 2] **Below Foundations and Slabs-on-grade**	98% of the material's maximum dry density value as determined by ASTM Standard Test Method D 698

Item	Description
Moisture Content - Cohesive Soil	Generally -2% to +3% of optimum as determined by ASTM Standard Test Method D 698
Moisture Content - Granular Material [3]	Workable moisture level

1. We recommend that each lift of cohesive and granular structural fill be tested by Terracon for moisture content and compaction prior to the placement of additional structural fill. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.
2. If granular material is a coarse sand or gravel, and is of a uniform size, or has a low fines content, compaction comparison to relative density may be more appropriate.
3. The gradation of a granular material affects its stability and the moisture content required for proper compaction.

4.2.4 Grading and Drainage

Final surrounding grades should be sloped away from the structure on all sides to prevent ponding of water. Gutters and downspouts that drain water well beyond the footprint of the proposed structures are recommended. This can be accomplished through the use of splash-blocks, downspout extensions, and flexible pipes that are designed to attach to the end of the downspout. Flexible pipe should only be used if it is daylighted in such a manner that it gravity-drains collected water. Splash-blocks should also be considered below hose bibs and water spigots.

4.2.5 Construction Considerations

Unstable subgrade conditions could develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. Consideration could be given to providing a layer of crushed stone over the prepared building subgrade to provide a working mat in order to help expedite construction.

Upon completion of filling and grading, care should be taken to maintain the subgrade moisture content prior to construction of floor slabs and pavements. Construction traffic over the completed subgrade should be avoided to the extent practicable. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. If the subgrade should become frozen, desiccated, saturated, or disturbed, the affected material should be removed or these materials should be scarified, moisture conditioned, and recompacted prior to floor slab and pavement construction.

As a minimum, all temporary excavations should be sloped or braced as required by Occupational Safety and Health Administration (OSHA) regulations to provide stability and safe working conditions. Temporary excavations will probably be required during grading operations. The grading contractor, by his contract, is usually responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations as required, to maintain stability of both the excavation sides and bottom. All excavations should comply with applicable local, state and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards.

The geotechnical engineer and/or their authorized representative should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation; proof-rolling; placement and compaction of controlled compacted fills; backfilling of excavations into the completed subgrade, and just prior to construction of building floor slabs.

4.3 Shallow Foundations

Foundation design recommendations for the proposed structure are presented in the following paragraphs.

4.3.1 Design Recommendations

Description	Column	Wall
Net allowable bearing pressure [1, 2] ■ **On at least stiff natural cohesive soils or compacted structural fill**	2,000 psf	2,000 psf
Minimum dimensions	30 inches	18 inches
Minimum embedment below finished grade [3]	30 inches	30 inches
Approximate total settlement from foundation loads [2, 4]	1 inch	1 inch

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation.
2. Areas which expose undocumented fill, soft, medium stiff or loose soils should be overexcavated and backfilled per recommendations provided in Section 4.3.2.
3. For frost protection and to reduce the effects of seasonal moisture variations in the subgrade soils. For perimeter footing and footings beneath unheated areas.
4. The foundation settlement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footings, the thickness of compacted fill, ground improvement depth and the quality of the earthwork operations.

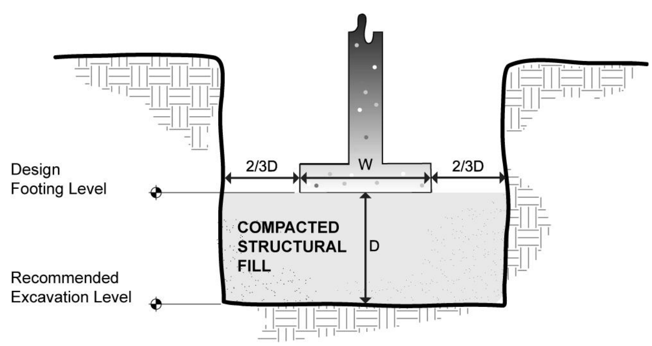
4.3.2 Construction Considerations

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. Should the soils at bearing level become excessively dry, disturbed or saturated, or frozen, the affected soil should be removed prior to placing concrete.

We recommend that concrete be placed within a few hours of excavation. If this cannot be achieved, a lean concrete mud mat should be placed in the bottom of the footing excavation.

If unsuitable bearing soils such as high plasticity soils, existing undocumented fill, soft to medium stiff or loose soils are encountered in footing excavations, the excavations 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. The footings could also bear on properly compacted backfill extending down to the suitable soils.

Overexcavation for compacted backfill placement below footings should extend laterally beyond all edges of the footings at least 8 inches per foot of overexcavation depth below footing base elevation. The overexcavation should then be backfilled up to the footing base elevation with well-graded granular material placed in lifts of 9 inches or less in loose thickness and compacted to at least 98 percent of the material's Standard Proctor maximum dry density (ASTM D 698). The overexcavation and backfill procedure is described in the figure below.



Overexcavation / Backfill

NOTE: Excavations in sketches shown vertical for convenience. Excavations should be sloped as necessary for safety.

4.4 Floor Slab

4.4.1 Design Recommendations

ITEM	DESCRIPTION
Floor slab support	Subgrade prepared according to **Sections 4.1 and 4.2** [1]
Modulus of subgrade reaction	100 pounds per square inch per in (psi/in)
Aggregate base course [2]	4 inches of granular material

1. Assumes that if expansive material with shrink/swell potential is encountered at subgrade elevation, the material be undercut and replaced with low volume change material to a depth of 12 inches.

ITEM	DESCRIPTION
	Floor slabs should be structurally independent of any building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation. 2. The floor slab design should include an aggregate base course comprised of compacted, granular material at least 4 inches thick.

Slabs-on-grade should be isolated from structures and utilities to allow for their independent movement. Joints should be constructed at regular intervals as recommended by the American Concrete Institute (ACI) to help control the location of any cracking. Keyed and doweled joints should be considered.

The use of a vapor retarder should be considered beneath concrete slabs on grade that will be 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.

4.5 Pavements

4.5.1 Pavement Design Recommendations

Provided the existing soils and/or new engineered fill are tested, evaluated and prepared in accordance with the recommendations provided in this report, these materials should provide suitable pavement support. The subgrade materials within the proposed pavement areas are expected to consist primarily of lean clays and or 12 inch thick layer of low volume change structural fill material.

Pavement design criteria were not provided to us; therefore, we have provided minimum pavement sections based on our experience with similar projects. The thickness of each course is a function of subgrade strength, traffic, design life, serviceability factors, and frost susceptibility.

Assuming the pavement subgrades will be prepared as recommended within this report, but without specific traffic loading information, the following pavement sections should be considered minimums for this project. If traffic information becomes available, we should be contacted to reevaluate our pavement recommendations.

Pavement Section Thickness (inches)						
Traffic Area	**Alternative**	**Asphalt Concrete Surface Course**	**Asphalt Concrete Base Course**	**Portland Cement Concrete [1]**	**Aggregate Base Course [2]**	**Total Thickness**
	PCC	--	--	5.0	4.0	9.0

Pavement Section Thickness (inches)						
Traffic Area	**Alternative**	**Asphalt Concrete Surface Course**	**Asphalt Concrete Base Course**	**Portland Cement Concrete [1]**	**Aggregate Base Course [2]**	**Total Thickness**
Light Duty (Car Parking)	AC	1.5	2.5	--	6.0	10.0
Heavy Duty (Drive Areas)	PCC	--	--	6.0	4.0	10.0
	AC	1.5	3.5	--	8.0	13.0
Trash Container Pad [3]	PCC	--	--	8.0	4.0	12.0

1. 4,000 psi at 28 days. PCC pavements are recommended for trash container pads and in any other areas subjected to heavy wheel loads and/or turning traffic.
2. Crushed limestone base material
3. The trash container pad should be large enough to support the container and the tipping axle of the collection truck.

The design approach used to determine the asphalt pavement thicknesses presented in the table was based on the National Asphalt Pavement Association (NAPA), which is specific to low-volume pavements. Portland Cement Concrete (PCC) pavement thicknesses were based on the American Concrete Institute (ACI) design recommendations. The above sections represent minimum thicknesses and, as such, periodic maintenance should be anticipated.
For concrete pavement, proper joint spacing will also be required to reduce the potentials of excessive slab curling and shrinkage cracking. All joints should be sealed to prevent entry of foreign material and dowelled where necessary for load transfer. Refer to ACI 330 “Guide for Design and Construction of Concrete Parking Lots” for additional information.

The granular base should be compacted to at least 98% of the maximum dry density, as determined by ASTM D698 or evaluated in the field in a test strip subjected to repeated passes of a 10-ton, or heavier, roller. Asphalt concrete should be placed and compacted to between 92 and 97 percent of the material’s theoretical maximum density. All pavement mixes and materials should be approved prior to use.

4.5.2 Construction Considerations

On most project sites, the site grading is accomplished relatively early in the construction phase. Fills are placed and compacted, and the initial surface is prepared in a relatively uniform manner. However, as construction proceeds, excavations will be made into these areas, rainfall and surface water may saturate some areas, heavy traffic from construction equipment disturbs the subgrade, and surface irregularities are often filled with loose materials. As a result, the pavement subgrades should be carefully evaluated as the time for pavement construction approaches. Within a few days of planned paving, we recommend the pavement areas be rough graded and then proofrolled with a minimum 20 ton loaded tandem axle dump truck. Particular attention should be given to high traffic areas that have been rutted and disturbed, and to areas where backfilled trenches are located. Any areas found to be unstable should be repaired by removing and replacing the materials with properly compacted fill, or by scarifying, air drying and recompacting the soils to the specified density and moisture limits.

Base course and pavement materials should not be placed when the surface is wet. Surface drainage should be directed away from the edges of paved areas to minimize lateral moisture transmission into the subgrade.

Subdrainage should be a primary consideration in the proposed pavement areas to prevent water from accumulating within the aggregate base course. To this end, we recommend the installation of pipe underdrains radiating from catch basins under low points of pavements. Subgrade surfaces should be fine graded so that water seepage under the pavements will flow to the underdrains or to other suitable drainage outlets. Establishing subgrade slopes during site grading to promote rapid surface and base course drainage away from the pavement will extend its useful life.

A regular pavement maintenance program should be implemented to repair occasional pavement defects and distress that may develop over time and extend the useful life of the pavement. Pavement maintenance consists of both localized maintenance (e.g. crack sealing and patching) and global maintenance (e.g. surface sealing).

4.6 Seismic Considerations

Code Used	Site Classification
2012 International Building Code (IBC) [1]	D [2]

1. In general accordance with the *2012 International Building Code,* Table 1613.5.2.
2. The 2012 International Building Code (IBC) requires a site soil profile determination extending a depth of 100 feet for seismic site classification. The current scope requested does not include the required 100 foot soil/bedrock profile determination. Borings for the project extended to a maximum depth of approximately 26 feet and this seismic site class definition considers that similar or better conditions continue below the maximum depth of the subsurface exploration. Additional exploration to deeper depths could be performed to confirm the conditions below the current depth of exploration.

4.7 Concrete Retaining Wall

After the initial subsurface investigation additional information was provided by the architect for the reconstruction of a concrete poured retaining wall. An existing concrete retaining wall is present along the southern edge of the project right-of-way, towards the southern edge of the parking lot. The toe of the retaining wall leads into a concrete watercourse approximately 10 feet below existing grade of the parking lot. The existing wall extends approximately 175 feet from the east to west along the southern edge of the parking lot.

The proposed construction and recommendations for the new concrete poured retaining will require additional borings. The additional borings will need to be located at the top of the existing retaining wall no more than 6 feet from the wall on the west and east ends of the wall alignment. It is recommended to obtain a minimum of three additional borings, based on the precise height of the wall for external stability analysis.

5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, 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. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

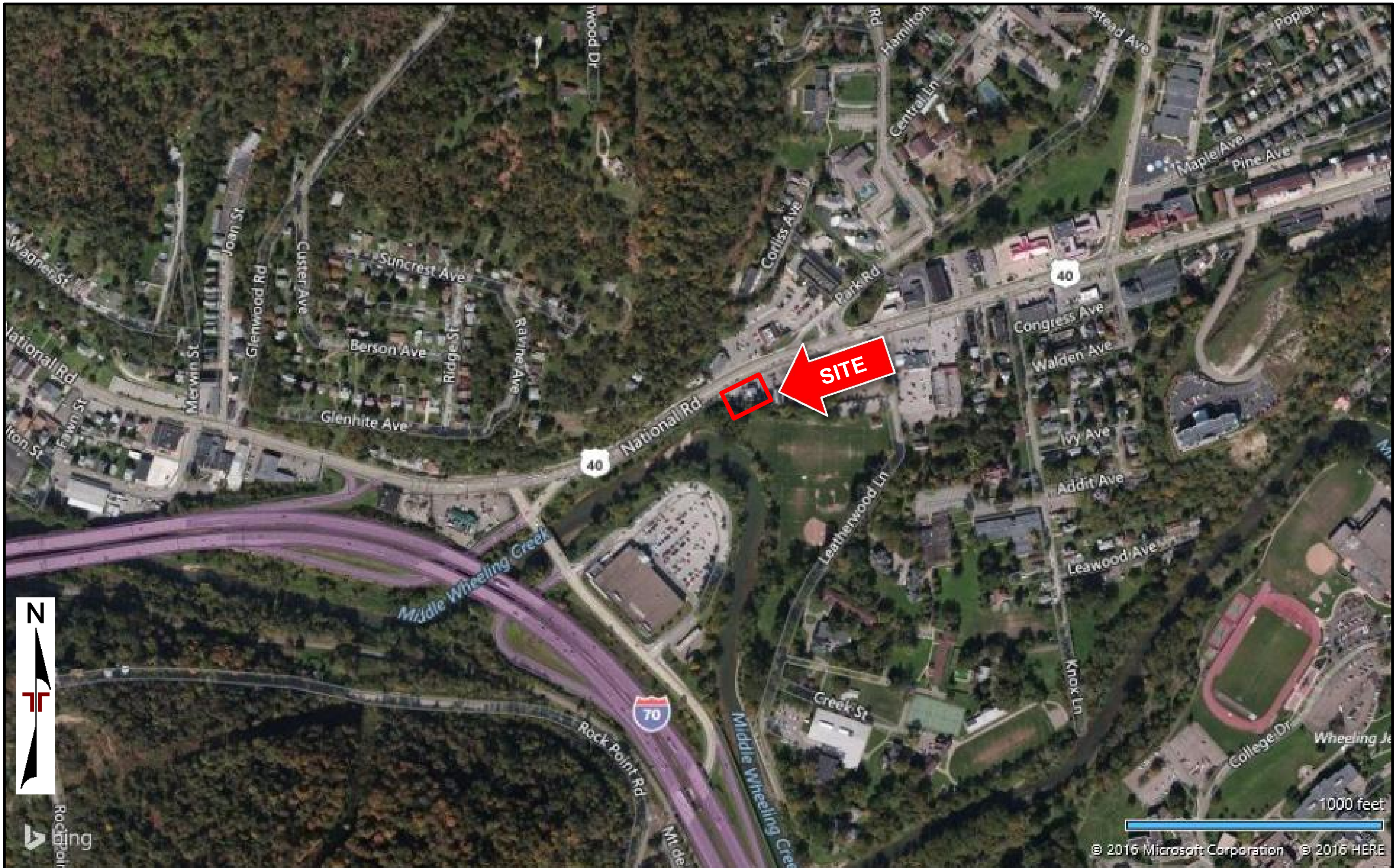
The support of pavements over some thickness of existing fill is discussed in this report. However, even with the recommended construction testing, there is a risk that unsuitable materials within or buried by the fill will not be discovered. This risk cannot be eliminated without the removing the fill, but can be reduced through exploration and testing during construction.

Soils prone to shrink/swell characteristics are present on this site. This report provides recommendations to help mitigate the effects of soil shrinkage and swell. However, even if these procedures are followed, some movement and cracking in the structure should be anticipated. The severity of cracking and other damage such as uneven floor slabs may increase if any modification of the site results in excessive wetting or drying of the shrink/swell prone soils. Eliminating the risk of movement and distress may not be feasible, but it may be possible to further reduce the risk of movement if significantly more expensive measures are used during construction. We would be pleased to discuss other construction alternatives with you upon request.

The scope of services for this project 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.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION



TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY QUADRANGLES INCLUDE: WHEELING, WV (1/1/1994). DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES	Project Manager: JPPG Drawn by: JPPG Checked by: KME Approved by: KME	Project No. N2165027 Scale: AS SHOWN File Name: BLP_SLP Date: 02/02/2016	Terracon **912 Morris Street** **Charleston, West Virginia 25301**	SITE LOCATION PLAN CHARTER FOODS **Wheeling Taco Bell Restaurant** **770 National Road, Wheeling, West Virginia**	Exhibit A-1

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

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

Project Manager: JPPG	Project No. N2165027
Drawn by: JPPG	Scale: AS SHOWN
Checked by: KME	File Name: BLP SLP
Approved by: KME	Date: 02/02/2016

Terracon
912 Morris Street
Charleston, West Virginia 25301

BORING LOCATION PLAN

CHARTER FOODS
Wheeling Taco Bell Restaurant
770 National Road, Wheeling West Virginia

Exhibit
A-2

Field Exploration Description

Six (6) test borings were drilled at the site on January 28, 2016. The boring locations were staked in the field by Terracon personnel. The ground surface elevations and coordinates at the boring locations were estimated from Google Earth software and are approximate. The locations and elevations of the borings should be considered accurate only to the degree implied by the means and methods used to define them. The approximate boring locations are indicated on the attached Exploration Plan.

The borings were drilled with a track-mounted rotary drill rig using continuous flight hollow-stem augers to advance the boreholes. Samples of the soil encountered in the borings were obtained using the split barrel sampling procedures.

In the split-barrel sampling 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 CME auto-hammer with a free fall of 30 inches, is the standard penetration resistance value (SPT-N). This value is used to estimate the in-situ relative density of cohesionless soils and consistency of cohesive soils.

A CME automatic SPT hammer was used to advance the split-barrel sampler in the borings performed on this site. A significantly greater efficiency is achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. This higher efficiency has an appreciable effect on the SPT-N value.

The soil samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. Information provided on the boring logs attached to this report includes soil descriptions, consistency evaluations, boring depths, sampling intervals, and groundwater conditions. The borings were backfilled with cuttings prior to the drill crew leaving the site.

A field log of each boring was prepared by the drill crew. These logs included visual classifications of the materials encountered during drilling, as well as, the driller's interpretation of the subsurface conditions between samples. Final boring logs included with this report represent the engineer's interpretation of the field logs and include modifications based on laboratory observation and tests of the samples.

BORING LOG NO. B-1

PROJECT: Taco Bell Restaurant

CLIENT: Charter Foods

SITE: 770 National Road
Wheeling, West Virginia

LOCATION See Exhibit A-2

Latitude: 40.075827° Longitude: -80.698338°

Surface Elev.: 648 (Ft.)

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)
0.5	**ASPHALT**	647.5						
1.5	**FILL - POORLY GRADED GRAVEL**, trace clay, gray, calcareous rock fragments, slag, and coal encountered	646.5			X	15	32-9-5 N=14	
6.5	**FILL - LEAN CLAY WITH COAL**, gray to yellow, weak cementation, interbedded laminated shale, coal encountered at a depth of 5 feet	641.5			X	6	3-2-2 N=4	
			5		X	18	7-1-1 N=2	
11.5	**LEAN TO FAT CLAY (CL)**, gray to brown, medium stiff to stiff	636.5			X	18	0-3-4 N=7	6500 (HP)
			10		X	18	3-3-4 N=7	5500 (HP)
	Boring Terminated at 11.5 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

Elevation Reference: Google Earth

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
912 Morris Street
Charleston, West Virginia

Boring Started: 1/28/2016	Boring Completed: 1/28/2016
Drill Rig: Track	Driller: FORE
Project No.: N2165027	Exhibit: A-4

BORING LOG NO. B-2

PROJECT: Taco Bell Restaurant

CLIENT: Charter Foods

SITE: 770 National Road, Wheeling, West Virginia

LOCATION See Exhibit A-2

Latitude: 40.076041° Longitude: -80.697914°

Surface Elev.: 655 (Ft.)

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)
0.5	**ASPHALT**	654.5						
	FILL - POORLY GRADED GRAVEL, trace clay, gray to orangish-brown, calcareous rock fragments, slag, and coal encountered, slight natural gas odor at depths ranging from 0 to 4 feet, thin lean clay seam encountered at 5 feet				X	8	33-22-19 N=41	
					X	12	11-10-10 N=20	
			5		X	11	7-4-3 N=7	
9.0		646		▽	X	2	3-3-7 N=10	
	LEAN TO FAT CLAY, gray to brown, soft to medium stiff, trace coal		10		X	6	1-1-2 N=3	
11.5		643.5						

Boring Terminated at 11.5 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

Elevation Reference: Google Earth

WATER LEVEL OBSERVATIONS

▽ *Water was observed at 8.5' after boring*

Terracon
912 Morris Street
Charleston, West Virginia

Boring Started: 1/28/2016	Boring Completed: 1/28/2016
Drill Rig: Track	Driller: FORE
Project No.: N2165027	Exhibit: A-5

BORING LOG NO. B-3

PROJECT: Taco Bell Restaurant

CLIENT: Charter Foods

SITE: 770 National Road, Wheeling, West Virginia

LOCATION See Exhibit A-2

Latitude: 40.075867° Longitude: -80.697954°

Surface Elev.: 648 (Ft.)

DEPTH	Description	ELEVATION (Ft.)
0.5	**ASPHALT**	647.5
9.0	**FILL - LEAN CLAY WITH ROCK FRAGMENTS**, gray, soft to medium stiff, weak cementation, interbedded laminated shale, slag, concrete, and coal encountered at variable depths within layer	639
21.5	**LEAN TO FAT CLAY (CL)**, gray to brown, soft, coarse sand and fine rock fragments encountered at a depth of 20 feet	626.5
	Boring Terminated at 21.5 Feet	

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)
0–1.5		X	10	37-17-17 N=34	
2.5–4		X	2	5-7-3 N=10	
5–6.5		X	10	3-4-2 N=6	
7.5–9		X	10	3-2-0 N=2	
10–11.5		X	14	0-0-2 N=2	2000 (HP)
14.8	▽				
15–16.5		X	13	2-1-1 N=2	1500 (HP)
20–21.5		X	10	14-14-12 N=26	

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:
Elevation Reference: Google Earth

WATER LEVEL OBSERVATIONS

▽ *Water was observed at 14.8' after boring*

Terracon
912 Morris Street
Charleston, West Virginia

Boring Started: 1/28/2016	Boring Completed: 1/28/2016
Drill Rig: Track	Driller: FORE
Project No.: N2165027	Exhibit: A-6

BORING LOG NO. B-4

PROJECT: Taco Bell Restaurant

CLIENT: Charter Foods

SITE: 770 National Road
Wheeling, West Virginia

LOCATION See Exhibit A-2

Latitude: 40.076016° Longitude: -80.697997°

Surface Elev.: 655 (Ft.)

DEPTH	Description	ELEVATION (Ft.)
0.5	**ASPHALT**	654.5
4.0	**FILL - POORLY GRADED GRAVEL**, trace clay, gray, various calcareous rock fragments, slag, and coal encountered	651
9.0	**FILL - LEAN CLAY WITH ROCK FRAGMENTS**, gray to orangish-brown, weak cementation, interbedded laminated shale, coal encountered at a depth of 5 feet	646
21.5	**LEAN TO FAT CLAY (CL)**, gray to brown, soft, coarse sand and fine rock fragments encountered at a depth of 20 feet	633.5
	Boring Terminated at 21.5 Feet	

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)
0–1.5		X	13	37-26-17 N=43	
2.5–4		X	18	8-7-4 N=11	
5–6.5		X	15	3-3-6 N=9	
7.5–9		X	18	2-2-2 N=4	
10–11.5		X	18	1-1-1 N=2	2000 (HP)
15–16.5	▽ (15.1)	X	18	0-1-1 N=2	2000 (HP)
20–21.5		X	18	6-5-7 N=12	

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:
Elevation Reference: Google Earth

WATER LEVEL OBSERVATIONS

▽ *Water was observed at 15.1' after boring*

Terracon
912 Morris Street
Charleston, West Virginia

Boring Started: 1/28/2016	Boring Completed: 1/28/2016
Drill Rig: Track	Driller: FORE
Project No.: N2165027	Exhibit: A-7

BORING LOG NO. B-5

PROJECT: Taco Bell Restaurant

CLIENT: Charter Foods

SITE: 770 National Road, Wheeling, West Virginia

LOCATION See Exhibit A-2

Latitude: 40.076011° Longitude: -80.698059°

Surface Elev.: 656 (Ft.)

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)
	CONCRETE AND BRICK FILL				X	2	10-6-6 N=12	
					X	3	2-1-2 N=3	
5.0		651	5					
	FILL - LEAN CLAY WITH ROCK FRAGMENTS, gray to brown, coal encountered at a depth of 7.5 feet, coarse sand encountered at a depth ranging from 5 to 6 feet				X	12	15-3-2 N=5	
					X	15	0-3-3 N=6	
9.0		647						
	LEAN TO FAT CLAY (CL), gray to brown, soft to medium stiff, trace coal fragments at a depth ranging from 10 to 11.5 feet, coarse sand and fine rock fragments encountered at a depth of 20 feet		10		X	16	3-2-2 N=4	2500 (HP)
			15	▽	X	18	2-2-2 N=4	
			20		X	15	6-6-7 N=13	
21.5		634.5						
	Boring Terminated at 21.5 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:
Elevation Reference: Google Earth

WATER LEVEL OBSERVATIONS

▽ *Water was observed at 15.3' after boring*

Terracon
912 Morris Street
Charleston, West Virginia

Boring Started: 1/28/2016	Boring Completed: 1/28/2016
Drill Rig: Track	Driller: FORE
Project No.: N2165027	Exhibit: A-8

BORING LOG NO. B-6

PROJECT: Taco Bell Restaurant

CLIENT: Charter Foods

**SITE: 770 National Road
Wheeling, West Virginia**

LOCATION See Exhibit A-2

Latitude: 40.07586° Longitude: -80.698028°

DEPTH	ELEVATION (Ft.) / Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY ()	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)
0.5	**CONCRETE AND BRICK FILL**						
1.5	**FILL - POORLY GRADED GRAVEL WITH SAND**, brown, calcareous rock fragments, slag, and coal encountered			X	2	1-2-1 N=3	
6.5	**FILL - LEAN CLAY WITH COAL**, gray, coal encountered from a depth ranging from 2.5 to 6.5 feet			X	12	6-13-7 N=20	
		5		X	13	2-1-1 N=2	
21.5	**LEAN TO FAT CLAY**, gray to brown, soft to medium stiff, trace coal encountered at a depth ranging from 9 to 11.5 feet, coarse sand and fine rock fragments encountered at a depth of 20 feet			X	18	0-0-6 N=6	2500 (HP)
		10		X	13	5-5-6 N=11	3000 (HP)
		15	▽	X	16	2-1-2 N=3	
		20		X	12	10-11-10 N=21	

Boring Terminated at 21.5 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3.25" Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

Elevation Reference: Google Earth

WATER LEVEL OBSERVATIONS

▽ *Water was observed at 15.2' after boring*

Terracon
912 Morris Street
Charleston, West Virginia

Boring Started: 1/28/2016	Boring Completed: 1/28/2016
Drill Rig: Track	Driller: FORE
Project No.: N2165027	Exhibit: A-9

APPENDIX B

LABORATORY TESTING

Laboratory Testing

As a part of the laboratory testing program, the soil samples were classified in the laboratory based on visual observation, texture, and moisture content and Atterberg limit test results. The soil descriptions presented on the boring logs for native soils are in accordance with our enclosed General Notes and the Unified Soil Classification System. The estimated group symbol for the USCS is also shown on the boring logs, and a brief description of the Unified System is included in this report.

APPENDIX C

SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING

Auger	Split Spoon
Shelby Tube	Macro Core
Ring Sampler	Rock Core
Grab Sample	No Recovery

WATER LEVEL

- Water Initially Encountered
- Water Level After a Specified Period of Time
- Water Level After a Specified Period of Time

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

(HP)	Hand Penetrometer
(T)	Torvane
(b/f)	Standard Penetration Test (blows per foot)
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels, sands and silts.			**CONSISTENCY OF FINE-GRAINED SOILS** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength, Qu, psf**	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**
Very Loose	0 - 3	0 - 6	Very Soft	less than 500	0 - 1	< 3
Loose	4 - 9	7 - 18	Soft	500 to 1,000	2 - 4	3 - 4
Medium Dense	10 - 29	19 - 58	Medium-Stiff	1,000 to 2,000	4 - 8	5 - 9
Dense	30 - 50	59 - 98	Stiff	2,000 to 4,000	8 - 15	10 - 18
Very Dense	> 50	≥ 99	Very Stiff	4,000 to 8,000	15 - 30	19 - 42
			Hard	> 8,000	> 30	> 42

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

Terracon

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification: Group Symbol	Soil Classification: 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]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [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]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [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" line [J]	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] $Cu = D_{60}/D_{10} \qquad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains $\geq$ 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 $\geq$ 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 $\geq$ 30% plus No. 200 predominantly sand, add "sandy" to group name.

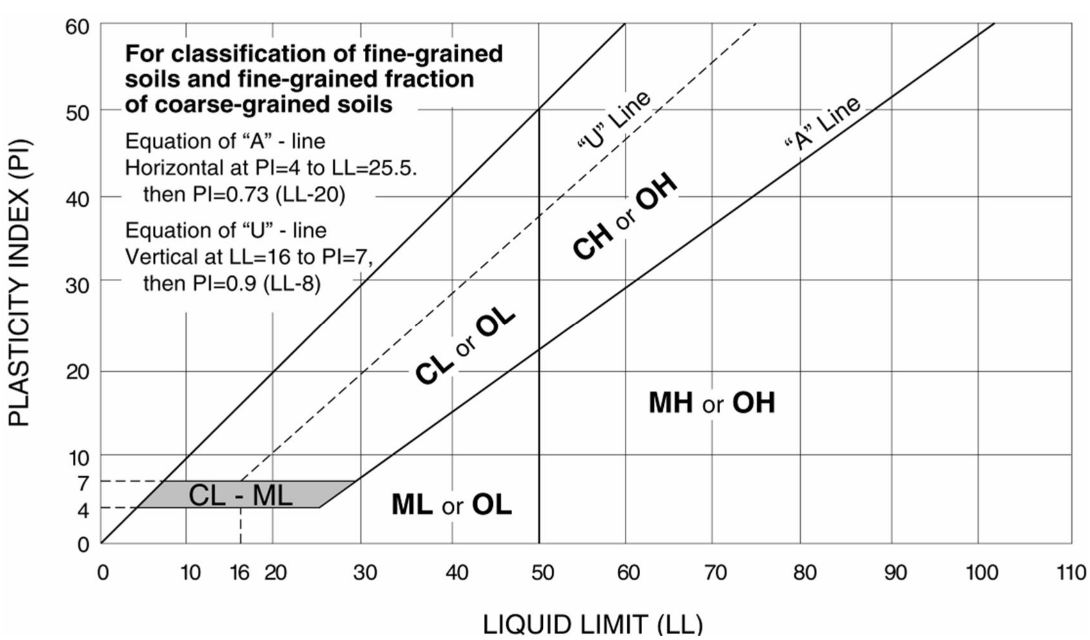
[M] If soil contains $\geq$ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] $PI \geq 4$ 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.



Terracon

DESCRIPTION OF ROCK PROPERTIES

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*)	
Description	**RQD Value (%)**
Very Poor	0 - 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 - 100

*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