# GEOTECHNICAL REPORT

## POPEYE'S LOUISIANA KITCHEN
## NORTHWEST CROSSINGS LOT 4
## BRIDGETON, MISSOURI

Gateway No. 1506411
March 2016

**Civil Engineer** – Tait & Associates, Inc.

Gateway Geotechnical, LLC

Gateway Geotechnical, LLC

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March 14, 2016

Tait & Associates, Inc.
Attn: Ms. Laurie Clark, PE, Project Manager
6163 East County Road 16
Loveland, Colorado 80537

Reference: Geotechnical Exploration
Popeye's Louisiana Kitchen
Northwest Crossings Lot 4
Bridgeton, Missouri
Gateway No. 1506411

Ms. Clark,

Attached is our *Geotechnical Report* that was completed following your authorization. An *Executive Summary of Recommendations* highlighting geotechnical recommendations unique to this project is also attached, immediately following this letter. The entire report, including its appendix, should be reviewed and incorporated into the project's design and construction. Please do not hesitate to call should you have any questions regarding our recommendations.

We appreciate having been of service during this phase of the project and look forward to our continued work with you. We recommend that Gateway be included in appropriate meetings during the remainder of the design process and at the commencement of construction in a preconstruction meeting. As a continuation of our services, Gateway should be retained during construction to observe the encountered conditions and test the construction materials and placement.

Respectfully,
**GATEWAY GEOTECHNICAL, LLC**

Shari A. Cunningham, PE
Senior Geotechnical Engineer


Attachments: Executive Summary of Recommendations
Geotechnical Report

SAC/TMM/sac

https://d.docs.live.net/ea47200aa418217a/GG docs/Report 03-14-2016.doc

# EXECUTIVE SUMMARY OF RECOMMENDATIONS

## POPEYE'S LOUISIANA KITCHEN
## NORTHWEST CROSSINGS LOT 4
## BRIDGETON, MISSOURI

**The following recommendations are not to be used without reference to the accompanying report and its appendix for additional details and information.**

### Shallow Foundations

**Net Allowable Bearing Pressure** 2,500 pounds per square foot (psf) for continuous wall footings and 2,750 psf for isolated, square, column footings.

**Subgrade Bearing Materials** Newly placed low plastic structural fill.

**Subgrade Treatment** Observation and approval of existing fill by Gateway during construction. Remediation of high plastic clay where present within 2 feet below the foundation bearing level.

**Minimum Width** 24 inches for strip footings, 30 inches for square pads.

**Minimum Frost Depth** 30 inches.

**Estimated Settlement** 1 inch total, ¾ inch differential (see Section 5.3).

**Seismic Site Class (IBC 2009)** Site Class "E"

### Floor Slab

**Coefficient of Subgrade Reaction (k)** 125 pounds per square inch per inch deflection (pci).

**Minimum Base** 6-mil-thick polyethylene sheet over at least 4 inches of crushed rock.

**Subgrade Treatment** Observation and approval of existing fill by Gateway during construction. Remediation of high plastic clay where present within 3 feet below the floor slab bearing level.

### Site Development

**Fill Materials** On-site low plastic fill or imported low plastic materials.

**Compaction Criteria for Structural Fill** Minimum of 95 percent (cohesive soil) or 100 percent (granular materials) of Standard Proctor (ASTM D 698) maximum dry density.

### Other Considerations

Existing fill was observed in the upper 12 to 14 feet in the borings drilled near the proposed building footprint, and to depths of at least 6 feet elsewhere on the site. The fill is comprised mostly of low plastic silty clay, with some areas containing high plastic clay, crushed rock, and concrete fragments. The field and laboratory data suggest that the fill was probably placed with moisture and compaction control. The fill should be observed by Gateway during construction for approval.

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# GEOTECHNICAL REPORT

## POPEYE'S LOUISIANA KITCHEN
## NORTHWEST CROSSINGS LOT 4
## BRIDGETON, MISSOURI

### 1.0 INTRODUCTION

At the request of Ms. Laurie Clark, PE, Project Manager with Tait & Associates, Inc., Gateway Geotechnical, LLC (Gateway) provided a geotechnical exploration for a Popeye's Louisiana Kitchen to be constructed at the referenced site. The purpose of our study was to characterize and evaluate the subsurface conditions, provide recommendations for foundations, and address other geotechnical aspects. Our services were provided in general accordance with our June 16, 2015 proposal, which was authorized via email on December 15, 2015.

### 2.0 SITE AND PROJECT DESCRIPTION

The property is a 1.15-acre commercial lot located along the northwest side of the recently re-developed Northwest Crossings retail and commercial center. Lot 4 is the fourth parcel north of the center's entrance from Lindbergh Boulevard (U.S. Highway 67). At the time of this study, the site was recently graded and sparsely vegetated.

The project consists of an approximately 3,000-square-foot, one-story, restaurant building with a slab-on-grade floor and no basement, surrounded by paved parking and drives. We have not been provided with the structural loads for the restaurant; however, they are expected to be representative of light commercial construction. We have assumed the new structural loads will not exceed 5 kips per lineal foot along strip footings and 50 kips at individual column pads.

No information was provided regarding previous structures which may have been located on the property. Review of available historical aerial photographs indicates that past usage of this site may have included commercial development.

Gateway should be notified of any deviation from the above information and assumptions, so that we may review and possibly revise the recommendations contained in this report. No other information was available, prepared by Gateway, or others, that would affect the recommendations of this report.

### 3.0 FIELD EXPLORATION AND LABORATORY TESTING

A Utility Locate Request was submitted to Missouri One Call on January 29, 2016. Boring locations were marked by Gateway in the field by measuring from existing site features. Six borings were drilled on February 5, 2016 under subcontract to Midwest Drilling, Inc. at the approximate locations shown on the Location and Site Plan, Figure 1. The borings were backfilled with soil cuttings at the completion of the drilling operations.

The ground surface elevation at each boring location was estimated to the nearest foot from the survey drawing provided by Tait & Associates. The locations indicated in Figure 1 and elevations noted on the boring logs should be considered approximate.

The retained samples were manually-visually classified in our laboratory. Moisture content and pocket penetrometer values were obtained for each testable sample. Natural density and unconfined compressive strength tests were performed on the intact Shelby tube samples. Atterberg limits were determined on a selected sample to aid in classification and characterization.

## 4.0 SUBSURFACE CONDITIONS

Detailed information regarding the nature and thickness of the soils encountered, and the results of the field exploration and laboratory testing are shown on the Boring Logs in Appendix A. A Legend for Boring Logs is provided to aid with interpretation of the logs. Following are generalized subsurface conditions.

Existing fill was encountered in each of the borings, and extended to depths of about 12 to 14 feet in the building pad borings (B-1 through B-4), and at least 6 feet in the remaining two borings. The fill generally consists of low plastic silty clay, with some areas containing high plastic clay, crushed rock, and/or concrete fragments. Standard Penetration Test (SPT) values of 7 to 21 blows per foot (bpf) were obtained in the fill. Moisture contents were fairly uniform and ranged from the upper teens to low twenties.

The natural soil encountered in the borings consists of high plastic clay (CH in accordance with the Unified Soil Classification System and ASTM D 2487), low plastic silty clay (CL), and low plastic clayey silt (ML). The natural cohesive soils exhibited SPT values of 6 to 14 bpf, corresponding to medium stiff to stiff consistencies. The borings terminated at 10 to 35 feet below the ground surface without encountering auger refusal or intact rock.

The *Engineering Geology of St. Louis County, Missouri*, by Edwin E. Lutzen and John D. Rockaway, published in 1987 by the Missouri Department of Natural Resources (MoDNR), indicates the site lies in Subunit Ic which is comprised of lacrustrine (lake deposited) sediments of stratified sands, silts, and clays. The *Geologic Map of St. Louis City and County, Missouri* by K.G. Brill, Jr., published in 1991 by MoDNR, indicates the uppermost bedrock at the site is the Marmaton Group consisting of shale, clay, limestone, and coal. Well data published by MoDNR indicates bedrock was encountered at depths of 70 to 100 feet at locations within about ½ mile of the site.

Groundwater was observed at a depth of 25 feet in B-1, while the remaining borings terminated at 10 to 20 feet without encountering groundwater. It must be noted that the groundwater level is subject to seasonal and climatic variations and other factors, and may be present at different depths at a future date. Without extended periods of observation, accurate groundwater level measurements may not be possible, particularly in cohesive materials such as those found at this location. It is anticipated that groundwater will not significantly impact the planned construction.

## 5.0 DESIGN RECOMMENDATIONS

### 5.1 Existing Fill and High Plastic Clay

The borings encountered 12 to 14 feet of existing fill near the building pad, and at least 6 feet of fill elsewhere across the site. The majority of our field and laboratory test results are consistent with what we would expect from fill that was placed with moisture and compaction control, although a few areas are probably not as well compacted as others. No records were available to us regarding its placement. The high plastic clay comprising some zones of the fill poses a shrink-swell concern for shallow foundations and floor slabs. It would be prudent to anticipate that fills of varying material types, depths, and lateral extent could be present at the site.

Our approach with undocumented fill would normally be to recommend its complete removal within the building pad, or at a minimum, within the bearing zone of shallow foundations. However, because most of our test data is consistent with suitably compacted fill, it is our opinion that the fill may remain in place if observed and approved by Gateway during construction.

Leaving existing fill or below-grade elements in place carries a higher risk of foundation and floor settlement, and cracking and/or deflection in pavements, sidewalks, and other site features than if the fill and any below-grade elements were completely removed. If this slightly elevated risk is not acceptable, Gateway should be contacted for removal recommendations.

Because of its potential to shrink and swell with changes in moisture content, high plastic clay should not be present within the upper 2 feet below foundation bearing levels or within 3 feet below the bottom of the floor slab. Where high plastic clay is present within these restricted zones, remediation should be performed in accordance with our Construction Recommendations in Section 6.3. The footings and floor slab would then be constructed on newly placed or approved low plastic structural fill.

The methods of high plastic clay treatment described herein are based on generally accepted standards in the local engineering community; however, swell pressures and volume change potential greater than can be mitigated by these methods may exist. Consequently, the Owner should recognize that there remains a reduced risk that foundation and floor slab damage may occur, even after remedial treatment of the subgrade soil.

### 5.2 Shallow Foundations

The proposed building can be designed with shallow foundations. Following construction observation by Gateway to approve existing fill, and remediation of high plastic clay where required, the foundations are expected to bear on low plastic structural fill. Such spread footing foundations can be sized for a maximum net allowable bearing pressure of 2,500 pounds per square foot (psf) for continuous wall footings and 2,750 psf for individual, square, column pads.

Continuous wall footings should have a minimum width of 24 inches and column pads a minimum dimension of 30 inches. Exterior footings and foundations in unheated areas should be provided with at least 30 inches of soil cover for frost protection. Interior footings in heated areas may bear at a nominal depth below the floor slab.

For footings designed and constructed as recommended in this report, we estimate generally acceptable settlements of less than 1 inch total, and less than ¾ inch differential between adjacent footings.

### 5.3 Floor Slab

The floor slab is expected to be supported on low plastic structural fill, following construction observation by Gateway to approve existing fill and remediation of high plastic clay where required. We recommend that the floor slab be designed using a modulus of subgrade reaction (k) of 125 pounds per square inch per inch of deflection (pci). The floor slab should be supported on a minimum 4-inch-thick layer of crushed rock to help distribute concentrated loads and equalize moisture conditions beneath the slab. We recommend that 6-mil-thick polyethylene sheeting be placed immediately beneath the floor slab and above the crushed rock to slow the transfer of capillary moisture to the slab.

It is generally preferable to maintain structural separation between a floor slab and the foundation walls and column pads, using isolation joints. We also suggest that joints be placed in the floor slab on no more than 15-foot intervals in any direction. Such joints permit movement of the independent elements and help reduce random cracking that might otherwise be caused by restraint of shrinkage, slight rotations, heave, or settlement.

### 5.4 Seismic Considerations

The 2009 International Building Code (IBC) requires the design of buildings and their structural components to withstand seismic forces. Site coefficients, which are a function of the soil or rock type and consistency, are required for the calculation of minimum earthquake design forces. Based on the consistency of the soils encountered and the anticipated depth to bedrock, (as per Chapter 16), Site Class "E" should be used.

The site coefficient $F_a$ is a function of the Site Class and mapped spectral response acceleration at short periods ($S_s$), while the site coefficient $F_v$ is a function of the Site Class and mapped spectral response acceleration at 1-second periods ($S_1$). Based on Site Class "E" and the mapped values of 0.50 for $S_s$ and 0.15 for $S_1$, we calculate $F_a = 1.7$ and $F_v = 3.3$. Some vertical and horizontal movement should be expected during a major earthquake event.

### 5.5 Pavement Sections

Selection of the pavement section is dependent on the design life, traffic loads, subgrade strength, drainage characteristics, and the desired level of maintenance. Neither CBR testing nor formal pavement design was part of our scope for this project.

For planning purposes, the sections summarized in the following tables typically result in pavements that perform satisfactorily on similar subgrades and under the anticipated traffic loads. They are intended to roughly provide a pavement requiring routine maintenance for a 5-year period, minor repair and maintenance during the 5- to 10-year life of the pavement, and possibly major repairs and restoration after a 10-year service life.

The typical heavy-duty rigid concrete section should be considered at areas such as the drive-through lane, trash loading pad, truck unloading area, and parking lot entrances, where high wheel loads and turning traffic can lead to deflection in flexible pavement. Standard duty sections are intended for car traffic only. Concrete used in rigid pavement should have a minimum 28-day compressive strength of 4,000 pounds per square inch (psi) and 5 to 7 percent air entrainment by volume.

**Table 5.5.1 – Flexible Pavement Sections**

| Pavement Type | Compacted Thickness (inches) | |
|---|---|---|
| | Surface Course | Base Course |
| Standard Duty Asphaltic Concrete | 3 | 6 |
| Heavy Duty Asphaltic Concrete | 3 | 9 |

**Table 5.5.2 – Rigid Pavement Sections**

| Pavement Type | Thickness (inches) | |
|---|---|---|
| | Non-reinforced Concrete | Base Course |
| Standard Duty Rigid Pavement | 6 | Not required |
| Heavy Duty Rigid Pavement | 8 | 4 |

## 6.0 CONSTRUCTION RECOMMENDATIONS

### 6.1 Earthwork Quality Assurance

A preconstruction meeting including the Owner or Owner's Representative, Contractor, and Gateway should be conducted at the project site, or other appropriate location, prior to the commencement of earthwork.

The Owner should engage Gateway to perform field compaction testing of in-place fill and backfill according to ASTM D 6938 (nuclear density) and/or ASTM D 2937 (drive cylinder) methods, as applicable. At least 48 hours prior to planned earthwork, the contractor should provide or arrange for

the delivery of samples of each planned on-site or off-site borrow source for laboratory testing. Gateway will then perform sample classification according to ASTM D 2487, and provide the compaction control curve according to ASTM D 698 (standard Proctor) for each discreet sample.

The Contractor should provide notice at least 24 hours before compaction testing is required. Typically each lift is tested, with the Contractor proceeding with subsequent earthwork only after test results for previously completed work comply with requirements.

### 6.2 Site Preparation

Prior to commencing work, erosion-control measures should be provided to reduce soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties or water bodies. To permit installation of new construction, the site should be stripped of vegetation, including digging out root balls (if any) and grubbing roots. Existing above- and below-grade site improvements, including underground utilities to be abandoned, should be removed from at least 10 feet beyond the limits of the proposed construction, or as otherwise necessary to facilitate the new construction.

Where existing fill is to remain in place, the upper 8 to 10 inches should be scarified, moisture adjusted as needed, and recompacted to at least 90 percent of its standard Proctor maximum dry density. The subgrade should be proofrolled with heavy pneumatic-tired or other equipment approved by Gateway to identify soft pockets and areas of excess yielding. Soft areas or otherwise unacceptable materials, if encountered, should be removed and replaced with structural fill or stabilized prior to placing additional fill. Wet or saturated subgrades should not be proofrolled.

Existing below-grade elements that are encountered outside of the building area may be left in place provided slabs are sufficiently broken to allow drainage, it can be verified that large pieces are not nested together, and the elements left in place are at least 3 feet below proposed subgrade.

Subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities should be reconstructed, as directed by Gateway. Surfaces should be graded to direct surface runoff water away from the construction area and to prevent ponding.

### 6.3 Excavations

The soils at this site are susceptible to disturbance in the presence of moisture and the traffic of construction. Care should be exercised to protect exposed subgrades from damage during construction, particularly during cold or wet weather. Temporary ditching and sumping may be dictated by the conditions encountered during construction to collect and discharge collected water away from the work area.

High plastic clay should be overexcavated where present to a minimum depth of 2 feet below the base of footings and 3 feet below the floor slab. The overexcavations should extend horizontally at least 2 feet beyond the outside edge of the footings and building footprint to facilitate uniform compaction of the replacement materials. The overexcavations should be backfilled with properly compacted low

plastic soil, limestone screenings, or 1-inch-minus crushed limestone. Lean concrete can be used as backfill beneath shallow footings; in this event, the overexcavation need not extend beyond the edges of the footing.

Chemical admixtures such as hydrated lime or Code L (also referred to as lime kiln dust) can be used to reduce the plasticity of soil, and could be considered as an alternative to overexcavation and replacement, particularly during cold or wet weather. However, the use of chemical admixtures is not recommended at this site due to its somewhat limited working area and proximity to areas which will remain in use during construction.

Utility trenches, basements, footings, and other excavations should comply with the OSHA regulation *Construction Standards for Excavations, 29 CFR, Part 1926, Subpart P*, and must be made under the supervision of qualified site personnel.

### 6.4 Structural Fill Materials

Fill and backfill placed under building foundations and floor slabs, pavements, retaining walls, slopes steeper than 4 horizontal to 1 vertical, walkways, and stairs is considered to be structural fill. It should have a liquid limit less than 45 percent and a plastic index less than 25 percent. Acceptable non-organic fill soils include materials designated CL, ML, CL-ML, SP, SW, GP, and GW by the Unified Soil Classification System, and free of rock or salvaged asphaltic or concrete elements larger than 4 inches in any dimension, debris, waste, frozen materials, vegetation, or other deleterious matter.

Existing fill may be re-used in structural fill provided unsuitable materials are segregated and removed. High plastic clay should not be re-used as structural fill within 2 feet below shallow foundations or 3 feet below the floor slab.

Materials designated CH, and otherwise meeting the requirements for acceptable fill materials indicated above, may be used as structural fill except within 2 feet and 3 feet below the base of the footings and floor slab, respectively.

Moisture contents in the upper portion of the borings ranged from the upper teens to low twenties. Some moisture adjustment via aeration or the addition of water should be anticipated in order to achieve suitable compaction of the on-site soils when used as structural fill.

### 6.5 Compaction Criteria

Cohesive structural fill materials should be compacted to at least 95 percent of their standard Proctor maximum dry density according to ASTM D 698. Aggregates and granular materials should be compacted to a minimum of 100 percent of the same criterion. In landscaped areas, compaction to at least 90 percent of standard Proctor is acceptable.

The subgrade and each subsequent fill layer should be moistened or aerated before compaction to within approximately -2 to +4 percent of its optimum moisture content. Approved fill should then be

compacted in maximum 8-inch-thick loose layers for material compacted by heavy compaction equipment, and not more than 4 to 6 inches for material compacted by hand-operated equipment. Fill should not be placed on surfaces that are muddy, frozen, or contain frost or ice; these materials require removal prior to additional fill placement.

When Gateway reports that subgrades, fills, or backfills have not achieved the specified degree of compaction, the surface should be scarified and moistened or aerated as required, or removed and replaced to the depth required, prior to additional compaction.

### 6.6 Shallow Foundations and Floor Slab

Gateway should be notified when excavations have reached their required subgrade. If unsatisfactory soil is present, additional excavation and replacement with structural fill or other remediation will be recommended by Gateway.

Excavations should extend to final grade just before placing steel reinforcement and concrete. They should be clean and free of loose soil or uncompacted fill; and the bearing soils should be maintained as near as possible to their natural, undisturbed, moisture content. Surface water and groundwater should not be allowed to enter excavations and potentially soften the bearing surface, pond on prepared subgrades, or flood the project site and surrounding area. The exposed subgrade should be protected against freezing temperatures or frost, possibly requiring use of protective insulating materials.

Where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions, the grade should be repaired, re-established, reshaped, or recompacted, as directed by Gateway, to the specified tolerances.

## 7.0 RECOMMENDED CONSTRUCTION OBSERVATION AND TESTING

The following list summarizes Gateway's recommendations for a construction-phase observation and testing program. These items typically provide quality assurance in assessing design assumptions, and document related construction procedures for compliance with plans, specifications, and good engineering practice. Gateway should be retained to:

- Participate in a formal preconstruction meeting with the Owner's Representative and Contractor prior to construction.

- Observe site preparation activities, including proofrolling existing fill and removal of soft or otherwise unacceptable areas.

- Assess potential structural fill materials, including on-site and off-site sources.

- Provide subgrade observations and compaction testing of newly placed structural fill.

- Observe foundation excavations and floor slab subgrades for adequacy and character of bearing materials.

- Provide quality assurance testing of structural concrete.

- Provide subgrade observations and quality assurance testing of pavement base course, asphaltic concrete, and Portland cement concrete.

Gateway is also available to provide routine and rain-event observations at the site, maintain and update on-site paperwork, and provide SWPPP and Land Disturbance Permit submittals.

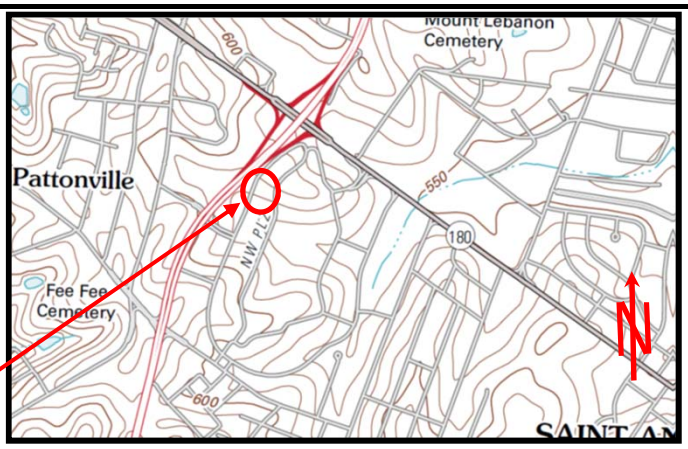
## 8.0 LIMITATIONS

The recommendations provided herein are for the exclusive use of our client. They are specific only to the project described, and are not meant to supersede more stringent requirements of local ordinances. They are based on subsurface information obtained at Gateway's six specific boring locations within the project area, and our understanding of the project as presented above. No other warranty is expressed or implied. Gateway should be contacted if conditions encountered are not consistent with those described.

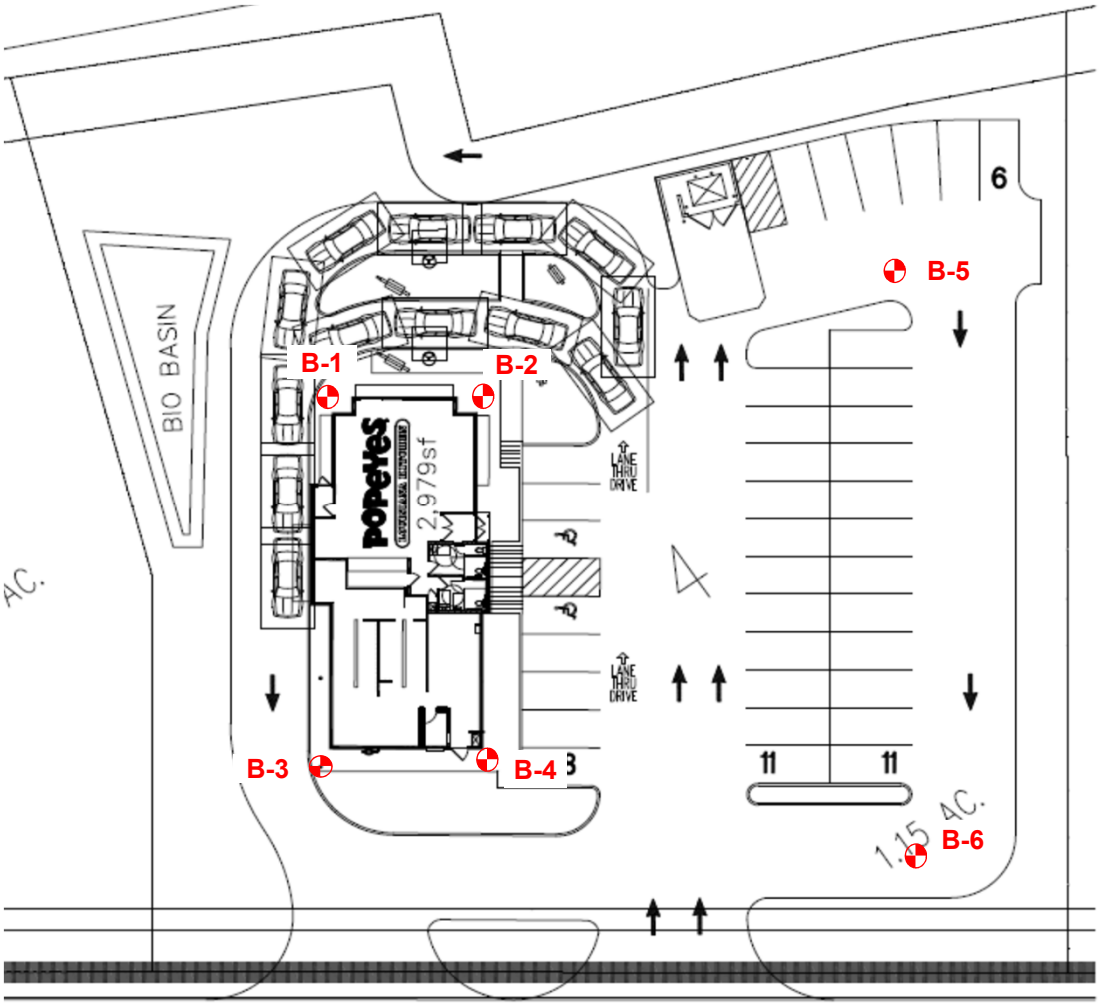
We should also be provided with a set of construction plans and specifications, when they are available, to review whether our recommendations have been understood and applied correctly. Failure to provide these documents to Gateway may nullify some or all of the recommendations provided herein. In addition, any changes in the planned project or changed site conditions may require revised or additional analyses and recommendations.

The final part of our geotechnical services should consist of direct observation during construction to observe that conditions encountered are consistent with those described in this report, and to assess the appropriateness of the analyses and recommendations contained herein. Gateway cannot assume responsibility or liability for the adequacy of its recommendations without being retained to observe construction.

* * *


**Approximate Location of Site (NTS)**




**Notes / Legend**

Approximate soil boring location

Site Plan provided by Tait & Associates, Inc.
Topographic map from USGS
Aerial photo from Google Earth
Figure should not be used outside the context of this report.

NOT TO SCALE

Popeye's Louisiana Kitchen
Northwest Crossings Lot 4
Bridgeton, Missouri

# LOCATION AND SITE PLAN

| Gateway No. 1506411 | March 2016 | Figure 1 |
|---|---|---|

# APPENDIX A

## POPEYE'S LOUISIANA KITCHEN
## NORTHWEST CROSSINGS LOT 4
## BRIDGETON, MISSOURI

Legend for Boring Logs
Boring Logs B-1 through B-6

# LEGEND
# FOR BORING LOGS

**Depth** in feet below ground surface.

**Material Description** indicates materials penetrated, typically soil or rock, using classification characteristics (ASTM D 2488) and the Unified Soil Classification System (ASTM D 2487). Secondary constituents are described as follows: trace for 0 to <10 percent, some for 10 to 35 percent, or by modifier to the main soil type for >35 percent.

**Stratigraphic Break** is indicated by a solid line where changes are observed in the field or retained samples, or a dashed line where changes are interpreted. Boundaries shown between described materials may be transitional or gradual.

**Sample Type**

- **SS** Disturbed sample obtained by driving a 2-inch-OD split-spoon (ASTM D 1586).
- **NX** NX-sized, nominal 2-inch-diameter rock core, obtained with a diamond coring bit (ASTM D 2113).
- **ST** Relatively undisturbed sample obtained by pushing a 3-inch-diameter, thin-walled, Shelby tube (ASTM D 1587).
- **CS** Relatively undisturbed sample obtained with the continuous sample tube system, using a split-barrel sampler in conjunction with auger advancement.
- **BS** Disturbed Bag Sample obtained from cuttings.

**Recovery** is the ratio of the length recovered to the total length driven, cored, or pushed, expressed as a percentage.

**RQD (Rock Quality Designation)** is the ratio of the total length of core segments more than 4 inches in length to the total length of core drilled (expressed as percentage). RQD is a general indicator of insitu rock quality as excellent for 90 to 100 percent, good for 75 to 90 percent, fair for 50 to 75 percent, poor for 25 to 50 percent, and very poor for 0 to 25 percent.

**Blow Counts** indicate the number of blows per 6 inches of split-spoon penetration when driven with a 140-pound hammer free falling 30 inches (ASTM D 1586). The total number of blows obtained for the second and third, 6-inch increments is the N value (Standard Penetration Test) in blows per foot. Practical refusal is considered to be 50 or more blows without achieving 6 inches of penetration, and is expressed as the ratio of 50 blows to actual penetration in inches. When obtained with an automatic hammer, the N value may be increased by a factor of 1.3 for analysis purposes.

**Laboratory Test Results**

- Pocket penetrometer value of apparently intact cohesive sample in kips per square foot (ksf).
- Unconfined compressive strength (ASTM D 2166) in kips per square foot (ksf).
- Dry density in pounds per cubic foot (pcf).
- Moisture content (ASTM D 2216) in percent.
- Liquid Limit and Plastic Index (ASTM D 4318) in percent.

**Elevation** in feet, corresponding to depth below ground surface.

# BORING LOG B-1



**Project:** Popeye's Louisiana Kitchen - Northwest Crossings Lot 4
**Project Number:** 1506411
**Location:** Bridgeton, Missouri

Gateway Geotechnical, LLC

**Ground Elevation:** 589 ft +/-
**Date Drilled:** 2/5/2016
**Drilling Contractor:** Midwest Drilling, Inc.
**Drilling Method:** CME 550 w/4" CFA

**Groundwater Levels (Depth, feet):**
- At Time Of Drilling: 25
- At End Of Drilling:
- +/- Hours After Drilling:

| Depth (ft) | Graphic | MATERIAL DESCRIPTION (UNIFIED SOIL CLASSIFICATION) | Sample Number & Type | Recovery % (RQD) | Blow Counts (per 6 in) | Pocket Penetrometer (ksf) | Unconfined Compressive Strength (ksf) | Dry Density (pcf) | Moisture Content (%) | Liquid Limit | Plastic Index | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | FILL : Brown low plastic silty clay. trace high plastic clay | | | | | | | | | | |
| | | | 1 SS | | 7-9-10 | 9.0+ | | | 18 | | | |
| | | *hard push for Shelby tube sample* | 2 ST | 95 | -- | 9.0+ | 5.1 | 108 | 20 | | | 585 |
| 5 | | grayish brown | 3 SS | | 6-6-9 | 6.5 | | | 19 | | | |
| | | brownish gray | 4 SS | | 5-7-9 | 9.0 | | | 19 | | | 580 |
| 10 | | | | | | | | | | | | |
| | | CLAY (CH): Brown and light brown, mottled | 5 SS | | 5-6-8 | 7.5 | | | 24 | | | 575 |
| 15 | | CLAYEY SILT (ML): Light gray, trace brown | | | | | | | | | | |
| | | | 6 SS | | 3-3-4 | 2.5 | | | 26 | | | 570 |
| 20 | | | | | | | | | | | | |

# BORING LOG B-1



**Project:** Popeye's Louisiana Kitchen - Northwest Crossings Lot 4

**Project Number:** 1506411

**Location:** Bridgeton, Missouri

Gateway Geotechnical, LLC

| Depth (ft) | Graphic | MATERIAL DESCRIPTION (UNIFIED SOIL CLASSIFICATION) | Sample Number & Type | Recovery % (RQD) | Blow Counts (per 6 in) | Pocket Penetrometer (ksf) | Unconfined Compressive Strength (ksf) | Dry Density (pcf) | Moisture Content (%) | Liquid Limit | Plastic Index | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | | CLAYEY SILT (ML): Light gray, trace brown *(continued)* | | | | | | | | | | |
| | | | 7 SS | | 2-3-3 | 2.5 | | | 26 | | | 565 |
| 25 | | brown | | | | | | | | | | |
| | | | 8 SS | | 4-4-4 | 2.0 | | | 27 | | | 560 |
| 30 | | | | | | | | | | | | |
| | | CLAY (CH): Light gray and brown | 9 SS | | 3-3-5 | 4.5 | | | 23 | | | 555 |
| 35 | | Boring terminated at 35 feet. | | | | | | | | | | |
| | | | | | | | | | | | | 550 |
| 40 | | | | | | | | | | | | |

# BORING LOG B-2



**Project:** Popeye's Louisiana Kitchen - Northwest Crossings Lot 4
**Project Number:** 1506411
**Location:** Bridgeton, Missouri

Gateway Geotechnical, LLC

**Ground Elevation:** 589 ft +/-
**Date Drilled:** 2/5/2016
**Drilling Contractor:** Midwest Drilling, Inc.
**Drilling Method:** CME 550 w/4" CFA

**Groundwater Levels (Depth, feet):**
**At Time Of Drilling:** None
**At End Of Drilling:**
**+/- Hours After Drilling:**

| Depth (ft) | Graphic | MATERIAL DESCRIPTION (UNIFIED SOIL CLASSIFICATION) | Sample Number & Type | Recovery % (RQD) | Blow Counts (per 6 in) | Pocket Penetrometer (ksf) | Unconfined Compressive Strength (ksf) | Dry Density (pcf) | Moisture Content (%) | Liquid Limit | Plastic Index | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | FILL: Brown low plastic silty clay | | | | | | | | | | |
| | | | 1 SS | | 4-6-7 | 9.0+ | | | 18 | | | |
| | | | | | | | | | | | | 585 |
| 5 | | dark brownish gray, trace brick, crushed rock, and organics | 2 SS | | 6-8-12 | 9.0+ | | | 19 | | | |
| | | grayish brown | 3 SS | | 4-6-8 | 5.5 | | | 20 | | | |
| | | brownish gray | | | | | | | | | | |
| | | | 4 SS | | 3-3-4 | 4.0 | | | 21 | | | 580 |
| 10 | | | | | | | | | | | | |
| | | SILTY CLAY (CL): Brown and light brown, mottled, trace organics | | | | | | | | | | |
| | | | 5 SS | | 3-3-5 | 3.5 | | | 27 | | | 575 |
| 15 | | Boring terminated at 15 feet. | | | | | | | | | | |
| | | | | | | | | | | | | 570 |
| 20 | | | | | | | | | | | | |

# BORING LOG B-3



**Project:** Popeye's Louisiana Kitchen - Northwest Crossings Lot 4
**Project Number:** 1506411
**Location:** Bridgeton, Missouri

Gateway Geotechnical, LLC

**Ground Elevation:** 589 ft +/-
**Date Drilled:** 2/6/2016
**Drilling Contractor:** Midwest Drilling, Inc.
**Drilling Method:** CME 550 w/4" CFA

**Groundwater Levels (Depth, feet):**
- **At Time Of Drilling:** None
- **At End Of Drilling:**
- **+/- Hours After Drilling:**

| Depth (ft) | Graphic | MATERIAL DESCRIPTION (UNIFIED SOIL CLASSIFICATION) | Sample Number & Type | Recovery % (RQD) | Blow Counts (per 6 in) | Pocket Penetrometer (ksf) | Unconfined Compressive Strength (ksf) | Dry Density (pcf) | Moisture Content (%) | Liquid Limit | Plastic Index | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | FILL: Brown high plastc clay, trace crushed rock | | | | | | | | | | |
| | | FILL: Brown low plastic silty clay | 1 SS | | 7-6-7 | 7.0 | | | 17 | 40 | 22 | |
| | | | | | | | | | | | | 585 |
| 5 | | | 2 SS | | 4-6-8 | 7.5 | | | 19 | | | |
| | | | 3 SS | | 5-7-9 | 9.0+ | | | 20 | | | |
| | | | 4 SS | | 6-8-10 | 9.0+ | | | 20 | | | 580 |
| 10 | | | | | | | | | | | | |
| | | SILTY CLAY (CL): Brownish gray, trace organics | | | | | | | | | | |
| | | | 5 SS | | 3-3-3 | 3.0 | | | 19 | | | 575 |
| 15 | | Boring terminated at 15 feet. | | | | | | | | | | |
| | | | | | | | | | | | | 570 |
| 20 | | | | | | | | | | | | |

# BORING LOG B-4



**Project:** Popeye's Louisiana Kitchen - Northwest Crossings Lot 4
**Project Number:** 1506411
**Location:** Bridgeton, Missouri

Gateway Geotechnical, LLC

**Ground Elevation:** 589 ft +/-
**Date Drilled:** 2/6/2016
**Drilling Contractor:** Midwest Drilling, Inc.
**Drilling Method:** CME 550 w/4" CFA

**Groundwater Levels (Depth, feet):**
**At Time Of Drilling:** None
**At End Of Drilling:**
**+/- Hours After Drilling:**

| Depth (ft) | Graphic | MATERIAL DESCRIPTION (UNIFIED SOIL CLASSIFICATION) | Sample Number & Type | Recovery % (RQD) | Blow Counts (per 6 in) | Pocket Penetrometer (ksf) | Unconfined Compressive Strength (ksf) | Dry Density (pcf) | Moisture Content (%) | Liquid Limit | Plastic Index | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | FILL: Brown low plastic silty clay | | | | | | | | | | |
| | | | 1 SS | | 5-6-8 | 9.0+ | | | 20 | | | |
| | | | | | | | | | | | | |
| | | | 2 SS | | 5-7-7 | 9.0+ | | | 18 | | | 585 |
| 5 | | | | | | | | | | | | |
| | | *hard push for Shelby tube sample* brown, trace gray | 3 ST | 100 | -- | 6.5 | 6.5 | 110 | 18 | | | |
| | | | | | | | | | | | | |
| | | | 4 SS | | 6-8-13 | 9.0+ | | | 17 | | | 580 |
| 10 | | | | | | | | | | | | |
| | | SILTY CLAY (CL): Brown and light brown, mottled | 5 SS | | 3-5-7 | 6.0 | | | 25 | | | 575 |
| 15 | | | | | | | | | | | | |
| | | CLAYEY SILT (ML): Light gray, trace brown | | | | | | | | | | |
| | | | 6 SS | | 2-3-3 | 2.0 | | | 29 | | | 570 |
| 20 | | | | | | | | | | | | |

Boring terminated at 20 feet.

# BORING LOG B-5



**Project:** Popeye's Louisiana Kitchen - Northwest Crossings Lot 4
**Project Number:** 1506411
**Location:** Bridgeton, Missouri

Gateway Geotechnical, LLC

**Ground Elevation:** 590 ft +/-
**Date Drilled:** 2/6/2016
**Drilling Contractor:** Midwest Drilling, Inc.
**Drilling Method:** CME 550 w/4" CFA

**Groundwater Levels (Depth, feet):**
**At Time Of Drilling:** None
**At End Of Drilling:**
**+/- Hours After Drilling:**

| Depth (ft) | Graphic | MATERIAL DESCRIPTION (UNIFIED SOIL CLASSIFICATION) | Sample Number & Type | Recovery % (RQD) | Blow Counts (per 6 in) | Pocket Penetrometer (ksf) | Unconfined Compressive Strength (ksf) | Dry Density (pcf) | Moisture Content (%) | Liquid Limit | Plastic Index | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | | | | 590 |
| | | FILL: Grayish brown low plastic silty clay | 1 SS | | 6-7-8 | 9.0 | | | 20 | | | |
| | | | 2 SS | | 3-4-5 | 5.5 | | | 20 | | | |
| 5 | | | | | | | | | | | | 585 |
| | | SILTY CLAY (CL): Brown | 3 SS | | 4-5-5 | 6.0 | | | 23 | | | |
| | | | 4 SS | | 4-5-6 | 4.5 | | | 24 | | | |
| 10 | | | | | | | | | | | | 580 |
| | | Boring terminated at 10 feet. | | | | | | | | | | |
| 15 | | | | | | | | | | | | 575 |
| 20 | | | | | | | | | | | | 570 |

# BORING LOG B-6



**Project:** Popeye's Louisiana Kitchen - Northwest Crossings Lot 4
**Project Number:** 1506411
**Location:** Bridgeton, Missouri

Gateway Geotechnical, LLC

**Ground Elevation:** 589 ft +/-
**Date Drilled:** 2/5/2016
**Drilling Contractor:** Midwest Drilling, Inc.
**Drilling Method:** CME 550 w/4" CFA

**Groundwater Levels (Depth, feet):**
**At Time Of Drilling:** None
**At End Of Drilling:**
**+/- Hours After Drilling:**

| Depth (ft) | Graphic | MATERIAL DESCRIPTION (UNIFIED SOIL CLASSIFICATION) | Sample Number & Type | Recovery % (RQD) | Blow Counts (per 6 in) | Pocket Penetrometer (ksf) | Unconfined Compressive Strength (ksf) | Dry Density (pcf) | Moisture Content (%) | Liquid Limit | Plastic Index | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | FILL: Crushed rock, concrete fragments, and brown silty clay | | | | | | | | | | |
| | | | 1 SS | | 9-11-9 | | | | 12 | | | |
| | | FILL: Brown low plastic silty clay, trace crushed rock | | | | | | | | | | |
| | | | 2 SS | | 3-4-4 | 3.5 | | | 21 | | | 585 |
| 5 | | dark brownish gray, trace brick, crushed rock, and organics | | | | | | | | | | |
| | | | 3 SS | | 5-9-12 | 7.0 | | | 20 | | | |
| | | dark brown | | | | | | | | | | |
| | | | 4 SS | | 4-5-7 | 7.0 | | | 21 | | | 580 |
| 10 | | Boring terminated at 10 feet. | | | | | | | | | | |
| | | | | | | | | | | | | 575 |
| 15 | | | | | | | | | | | | |
| | | | | | | | | | | | | 570 |
| 20 | | | | | | | | | | | | |