TACO BELL AT LANGLEY PARK

INTRODUCTION

Project Location

The project site is located in the northeast quadrant of the intersection of New Hampshire Avenue and Holton Lane in the Takoma Park area of Montgomery County, Maryland. A Site Location Map is provided in the Appendix.

Project Information and Site Conditions

In preparing the subsurface exploration program for this study, ECS was provided with a Site Layout Plan, as prepared by Bohler Engineering and dated February 27, 2014, which depicted the proposed development. We have also reviewed the Guidelines for Environmental Assessments and Geotechnical Engineering Studies prepared for Yum! Brands, dated 2006.

Topographic information was not available at the time of this report. The general site is currently developed with an Aldi store and associated parking areas, and is generally level. Proposed finished grades were not provided at the time this report was prepared, but it is our understanding that the finished grades will be within 2 ft of existing grades. Therefore, minor cuts and fills will be required to establish final grades.

Based on the information provided, we understand that the proposed construction is to consist of a one-story, 2,027 sf Taco Bell restaurant, pylon sign structure, and associated drive lanes and parking areas. In addition, we understand two (2) stormwater management (SWM) facilities are planned at the site; however, specific locations of these SWM facilities were not provided at the time of this report, but we understand that the facilities will be located within pavement areas. Structural loading information was not provided at the time this report was prepared; however, based on our experience with similar structures, we anticipate that maximum column loads will be on the order of 100 kips or less. No other construction, such as site retaining walls, was indicated on the provided plan.

Scope of Services

Our scope of services included drilling four (4) soil test borings, designated as: B-1 and B-2 for the structure, and P-1 and P-2 for the pavement section and pylon, and SWM facilities. The borings were drilled to depths of 15 ft to 30 ft each below existing grades. The approximate boring locations are presented on the Boring Location Plan in the Appendix.

All borings were drilled in general accordance with ASTM D 1586 standards. The scope of work also included visually classifying soil boring samples, performing laboratory testing on selected soil samples from the borings, performing various engineering analyses, and providing this written report of findings, evaluations and recommendations.

The report contains the following information:

a. Information regarding site conditions, including surface drainage, geology, and special site features;
b. Descriptions of the field exploration and laboratory testing procedures used;
c. Boring logs in accordance with the standard practice of geotechnical engineers, showing subsurface strata and descriptions, groundwater conditions, and results of field tests;
d. Results of laboratory tests on summary sheets and on individual test reports;
e. A Site Vicinity Map, a Boring Location Plan, and pertinent Reference Sheets;
f. Recommendations for allowable bearing pressure for conventional spread footing foundations and estimates of predicted foundation settlement;
g. Recommendations for lateral earth pressures likely to develop on below-grade walls, and perimeter drainage systems for below-grade walls, if required;
h. Evaluations and recommendations for geotechnical aspects of design and construction, including general site development, frost depths considerations, ground-supported slabs, stormwater management, pavement, seismic site classification, earthwork considerations, drainage, and other aspects of geotechnical-related design and construction.

EXPLORATION PROCEDURES

Subsurface Exploration Procedures

The soil borings were drilled with an ATV-mounted drill rig, using continuous-flight, hollow-stem augers to advance the boreholes. Drilling fluid was not used during advancement of the boreholes.

Representative soil samples were obtained by means of the split-barrel sampling procedure in general accordance with ASTM D 1586. In the split-barrel sampling procedure, a 2-inch O.D. split-barrel sampler is driven into the soil a distance of 18 inches by means of a 140-pound hammer falling 30 inches.

The number of hammer blows required to drive the sampler through the second and third 6-inch drive increments is termed the Standard Penetration Test (SPT) value (blow count, or N-value) and is indicated for each sample on the Boring Logs. In the borings, split-barrel sampling was performed at 2.5 ft intervals to depths of 10 ft and at 5.0 ft intervals thereafter.

N-values can be used to provide a qualitative indication of the in-place relative density of cohesionless soils. In a less reliable way, N-values also provide an indication of consistency for cohesive soils. The indications of relative density and consistency are qualitative, since many factors can significantly affect N-values and prevent direct correlations, including differences among drill crews, drill rigs, drilling procedures, and hammer-rod-sampler assemblies.

A field log of the subsurface conditions encountered in the borings was maintained by the Drill Crew during the drilling operations. Each recovered soil sample was removed from the sampler and visually classified by the Drill Crew. Representative portions of soil samples were sealed in glass jars and returned to the ECS laboratory for further visual examination and possible laboratory testing.

Laboratory Testing Program

The laboratory testing program included visual classification of the boring samples by an experienced Geotechnical Engineer. The classifications were based on texture and plasticity in accordance with the Unified Soil Classification System (USCS). A brief explanation of the USCS is included in the Appendix of this report. The USCS group symbol for each soil type is indicated in parentheses following the soil descriptions on the Boring Logs.

During the visual classification procedures, the Geotechnical Engineer grouped the various soil types into the major strata noted on the Boring Logs. The stratification lines designating the interfaces between various soil strata on the Boring Logs are approximate. In situ, these transitions will likely be gradual and could occur at slightly different levels from those shown on the Boring Logs.

The limited laboratory testing program included moisture content, percent passing the No. 200 sieve, and Atterberg Limits on selected boring samples to estimate engineering properties of the soils and to help verify the visual classifications. In addition, laboratory testing included gradation analysis by hydrometer for USDA classifications. The results of the laboratory testing are included in the appendix of the report.

The soil samples will be retained in the ECS laboratory for a period of 60 days. After that holding period, the samples will be discarded, unless ECS receives other instructions regarding their disposition.

EXPLORATION RESULTS

Geologic Conditions

The project site is located within the Atlantic Coastal Plain Physiographic Province, which is characterized by marine and river sediments deposited during successive periods of fluctuating sea level and moving shorelines. Generally, the sediments thicken from west to east, towards the Atlantic Ocean. The uppermost sediments are often comprised of interbedded sands, gravels, clays, and silts.

Based on the results of the test borings and a review of the *Geologic Map of Montgomery County, Maryland*, dated 1968, the natural soils at the project site are generally described as the Potomac Group (Kp), which consists of:

"Interbedded quartzose gravels; protoquartzitic to orthoquartzitic argillaceous sands; and white, dark gray and multicolored silts and clays. Thickness 0 to 800 feet."

Subsurface Conditions

In general, the conditions encountered at the ground surface during our field exploration consisted of 1 to 3 inches of asphalt over 6 to 8 inches of gravel, overlying natural soils. The natural soils were generally tannish gray, light brown, pinkish tan, grayish tan, dark brown, dark red, brown tannish brown, and gray. The natural soils consisted generally of Lean Clay (CL), Clayey SAND (SC), Sandy Lean Clay (CL), and Silty SAND (SM) soil types. The N-values recorded in the natural granular soils ranged from 8 blows per foot (bpf) to 17 bpf, indicating loose to medium dense relative densities. The N-Values recorded in the cohesive natural soils ranged from 4 bpf to 15 bpf, indicating soft to stiff consistencies. More detailed descriptions of the encountered subsurface conditions are provided on the boring log in the Appendix.

Water Level Observations

Groundwater level observations were made in the borehole, generally during the drilling operations and at completion of drilling operations, both before and after removal of the drilling augers. Groundwater was encountered in Boring P-1 at a depth of 22 ft below existing grade. Cave-in depths for the borings also were observed after removal of the drilling augers from the boreholes and ranged from 10.2 ft to 18.3 ft below existing grades.

Observations regarding the presence and absence of groundwater levels reflect the conditions at the time of this exploration only. Fluctuations in the locations of groundwater tables or perched water levels could occur as a result of seasonal variations in evaporation, precipitation, surface water run-off, and other factors. Therefore, water levels at future times could vary from those observed at the time of the borings.

ANALYSES AND RECOMMENDATIONS

Foundation Considerations

Based on the soil boring and subsurface conditions encountered, the soils at the footing subgrades of the proposed Taco Bell restaurant and pylon are anticipated to consist of firm natural soils, or new engineered fill material, placed on firm natural soil. Based on our understanding of the proposed construction and the results of the subsurface exploration, the proposed Taco Bell restaurant and pylon can be supported on conventional footings placed on firm natural soils or new fill placed on firm natural soils.

Footings placed on firm natural soils, or on new engineered fill placed on natural soils, can be designed for net allowable bearing pressures not to exceed 2,500 pounds per square foot (psf) for isolated column footings and continuous wall footings. The net allowable soil bearing pressure refers to the pressure that can be transmitted to the foundation bearing soils in excess of the final overburden pressure at the base of a footing

Prior to the placement of reinforcement and concrete for footings, the bases of the footing excavations should be observed, tested, and approved by a qualified representative of the Geotechnical Engineer to verify that soil conditions at each footing location are suitable for the design bearing pressure. If unsuitable soils are encountered at planned subgrade levels for any footing, the unsuitable soils should be undercut to suitable bearing materials. The footing can be directly supported on the competent soils at greater depths or, alternatively, the design footing bearing level can be restored through placement of lean concrete or select engineered fill materials.

If the design bearing level is restored using select engineered fill, then the excavation to remove the unsuitable soils should extend at least 0.5 ft laterally beyond the bottom edge of the footing for each 1 ft of vertical undercut below the footing bearing level. The select engineered fill materials should be placed and compacted as discussed in greater detail later in this report.

Settlement of the building and pylon foundations will be a function of the compressibility of the underlying subgrade soils, the actual applied loads, and other factors. Based on the anticipated maximum column loads in the range of 100 kips or less, the anticipated total settlements of individual footings, designed and constructed as outlined in this report, will be less than 1 inch. Maximum differential settlements within the proposed building are expected to be ½ inch over a horizontal distance of 30 feet.

In order to reduce the possibility of foundation bearing failure and excessive settlement due to local shear or "punching" action, we recommend that continuous footings have a minimum width of 2 feet and that isolated column footings have a minimum lateral dimension of 4 feet. In addition, footings should be placed at a sufficient depth to provide adequate protection against frost heave. We recommend that all footings be placed at a minimum depth of 30 inches below finished grade.

All continuous load-bearing wall foundations should be suitably reinforced. To provide continuity and minimize differential movements, the longitudinal reinforcing steel should be extended into any column footing situated along the walls (exterior or interior) and the foundations constructed as a continuous unit. The reinforcing steel should also be continuous through the building corners. Where top and bottom steel is included in the continuous wall foundations, a minimum footing thickness of 12 inches should be required. Prior to placing any foundation concrete, the steel reinforcement should be examined to ensure that the bars are properly sized and positioned in accordance with the foundation plans and specifications.

Ground Supported Floor Slabs

Building floor slabs may be ground-supported on subgrades prepared in accordance with the recommendations in the sections titled Subgrade Preparation and Fill Placement. It is important that the slab subgrade be firm and stable before the placement of the granular subbase materials, the moisture barrier, and the concrete. Based on the test boring results and the anticipated planned finished floor elevations, the anticipated slab subgrade should generally consist of firm natural soils, or new engineered fill.

The existing subgrade should be thoroughly proofrolled with suitable equipment and/or probed by a qualified representative of the Geotechnical Engineer in an effort to detect unstable or otherwise unacceptable soil conditions. Soils in any excessively unstable areas should be undercut and replaced with new engineered fill. Recommendations for construction of engineered fill are presented in the Fill Placement section of this report.

It is recommended that ground-supported slabs be underlain by a minimum of 4 inches of CR-6 or GA S/B dense-graded aggregate or approved equivalents. Acceptable granular subbase materials should have no aggregate size greater than 1.5 inches, 95 to 100 percent passing the 1 inch sieve, and less than 12 percent by total weight passing the Number 200 sieve. The granular subbase materials will provide a capillary break between the subgrade and the concrete slab, a higher modulus of subgrade reaction, and more uniform support conditions.

All granular materials should be compacted; however, if the granular subbase materials have more than 5 percent fines, those materials should be compacted to a minimum of 98 percent of the maximum dry density as determined by the Standard Proctor compaction test method (ASTM D 698). For structural design purposes, a modulus of subgrade reaction (k) of 120 pounds per cubic inch (pci) may be utilized for the structural design of slabs, provided a 4-inch subbase is utilized and the subgrade has been prepared in accordance with the recommendations presented herein.

In the event there is a significant time lag between the site grading work and the fine grading of concrete slab areas prior to the placement of the subbase stone or concrete, the Geotechnical Engineer should verify the condition of the prepared subgrade. Prior to final slab construction, the subgrade may require scarification and re-compaction to provide firm and stable conditions.

Where moisture vapor seepage through concrete slab is a concern, a moisture vapor barrier, consisting of at least 8 mil polyethylene sheets, should be placed on top of the granular materials before the placement of the concrete. However, with the use of a moisture vapor barrier, special attention should be given to the surface curing of the slab in order to minimize uneven drying of the slab and any associated cracking and curling.

It is recommended that ground-supported slabs be isolated from the foundation footings so that differential movement between the footings and slab will not induce excessive shear and bending stresses in the floor slab.

Where the structural configuration prevents the use of a free floating slab, the slab should be designed with suitable reinforcement and load transfer devices to preclude overstressing of the slab. Slabs must also be provided with proper control joints to minimize the effects of concrete shrinkage and differential settlements. To minimize the widths of any shrinkage cracks that may develop near the surface of the slab, it is recommended that welded-wire mesh reinforcement be provided. The welded-wire mesh should be in located the top half of the slab to be effective.

Below-Grade Walls and Site Retaining Walls

Based upon our understanding of the proposed construction, below-grade walls or site retaining walls are not anticipated. However, the following recommendations are provided to guide the general design of below-grade building walls and site retaining walls for lateral earth pressures, should such design be required.

It is very important with regard to construction of below-grade building walls and site retaining walls that soils within the critical zones behind the walls meet certain criteria with regard to soil type. For below-grade building walls, the critical zone can be considered as the zone between the bottom back edge of the wall footing and an imaginary line extending upward and rearward from the bottom back edge of the wall footing at a 45-degree angle.

It is recommended that all natural soils and backfill soils within the critical zones of the walls should have USCS classifications of Silty SAND (SM) or more granular. Any soils having classifications less granular than Silty SAND (SM) may need to be removed from the critical zones of the walls, as determined by the Geotechnical Engineer at the time of construction. Based upon the results of the borings and anticipated laboratory results, it would appear that the soils at the site should be suitable to remain in-place for use as wall backfill.

Backfill materials for below-grade walls should be placed and compacted in accordance with criteria outlined in the **Earthwork** section of this report. The minimum degree of compaction for backfill soils behind below-grade building walls and conventional retaining walls should be 95 percent of the Standard Proctor maximum dry density (ASTM D 698), unless otherwise approved by the Geotechnical Engineer.

It is important that below-grade building walls that generally are designed for minimal displacements at the top of the wall should not be backfilled until the walls are adequately braced by permanent structural framing.

Conversely, walls that are designed for active earth pressures generally should not be braced during backfill compaction, so that the walls can yield and rotate and develop active earth pressures. For yielding walls, it generally will be best not to place steel framing, or conventional masonry or concrete walls for the buildings, until wall backfilling operations have been completed.

Below-grade building walls and other retaining walls that are rigid and not free to rotate at the top should be designed for at-rest earth pressure conditions. Based on consideration of at-rest earth pressure conditions and typical properties for Silty SAND (SM) or more granular soil types, it is recommended that equivalent fluid pressures on walls from the retained soils be calculated as 60H, in units of pounds per square foot, where H is the height of the wall retaining soils in units of feet.

Walls that are flexible and free to rotate at the top can be designed for active earth pressure conditions. Based on consideration of active earth pressures and typical properties for Silty SAND (SM) or more granular soil types, it is recommended that equivalent fluid pressures on walls from retained soils be calculated as 40H, in units of pounds per square foot, where H is the height of the wall retaining soils in units of feet.

The design criteria presented above for evaluation of horizontal earth pressures on retaining walls are based on the assumption of level backfill conditions and the absence of free water within the wall backfill materials. Lateral pressures induced by sloping backfills and/or by any surcharge loadings adjacent to walls will also need to be considered in the wall designs. In addition, suitable drainage will need to be provided to intercept and to dispose of any surface infiltration and groundwater behind walls.

Sliding resistance for retaining wall footings can be computed using a coefficient of friction of 0.36 for granular soils and 0.30 for silty and clayey soils. Additional resistance to sliding from passive earth pressure resistance also can be considered, if the earth materials considered for passive resistance will remain in place on the low side of the retaining wall. Equivalent fluid pressures for passive earth pressure resistance can be computed as 250D, in units of pounds per square foot, where D is the depth of undisturbed natural soil or engineered fill that will remain in place above the base of the wall footing. Because the frictional and passive earth pressure resistances are based on limit strength conditions, appropriate factors of safety of at least 1.5 should be applied to the designs considering these resistances.

The Geotechnical Engineer can provide additional design guidance regarding these and other aspects of below-grade wall and retaining wall design upon request.

Seismic Classification

Section 1613.3.2 of the IBC 2012 refers to Chapter 20 of ASCE7 for seismic site classification, which is based on various criteria, one of which is the Standard Penetration Resistance, N_{bar}, derived from the Standard Penetration Test Procedure (ASTM D-1586). ASCE7 Table 20.3.1 provides correlations for Site Classes C, D, and E with various ranges of N_{bar} to be calculated for the top 100 feet of the subsurface materials at a site in accordance with procedures described in Section 20.4.2 of ASCE7. In addition, the table presents criteria related to various soil properties for Site Classes E and F. ECS has used Table 20.3.1 of ASCE7 and the procedures outlined in Section 20.4.2 of ASCE7 to evaluate the Site Class for this project site.

Based on our review of the soil test boring results, it appears that the average N_{bar} value should be in the range between 15 bpf and 50 bpf over a depth of 100 ft. This N_{bar} places the project site within the Site Classification of D, according to Table 20.3.1 of ASCE7.

Pavement Construction

Details regarding traffic conditions anticipated for the site were not provided. However, based on our previous experience, it is ECS' opinion that two pavement sections generally should be considered for use – a light-duty pavement section for areas that will be subjected primarily to automobile and light-truck traffic and a medium-duty pavement section for areas that will be subjected to some routine heavier delivery and trash pickup truck traffic, in addition to normal automobile and light-truck traffic.

It is our judgment that traffic conditions associated with light-duty pavements can be represented by approximately 15,000 18-kip equivalent single-axle loads (ESALs) during an approximately 20-year service life, while traffic conditions associated with medium-duty pavements can be represented by approximately 75,000 ESALs during an approximately 20-year service life.

It is ECS' opinion that use of the light-duty pavement section and the medium-duty pavement section most likely will be sufficient for traffic conditions likely to occur at the development. However, traffic loading conditions are an extremely important parameter with regard to pavement design. Therefore, if the traffic condition estimates provided above are considered to be inappropriate for the project, please advise ECS so that revised pavement section designs can be determined for this site. Final decisions regarding pavement sections can be made as project design progresses, when further input regarding likely traffic conditions can be provided by other Design Team members.

Subgrade support conditions are the other major parameter of importance to pavement design and performance. Final grades were not available at the time of this report; However based on the boring results, it is anticipated that the subgrade soil conditions exposed at final subgrade levels when the project site is graded prior to pavement construction will generally consist of Lean Clay (CL) or Sandy Lean Clay (CL) or new fill material. We recommend conducting California Bearing Ratio tests on planned subbase material once the subgrade for the planned parking areas and drive lanes are established.

Based upon our previous experience with similar projects and site conditions, it is our judgment that the typical pavement subgrade soils such as the soils encountered at the site could exhibit a minimum California Bearing Ratio (CBR) value of 3 when compacted to at least 95 percent of the maximum dry density, as determined by the Standard Proctor test (ASTM D 698). Therefore, for pavement design a CBR value of 3 is considered. If material having a CBR value of less than 3 is encountered at pavement subgrades, it is recommended to over excavate the top 12 inches of this material at the pavement subgrade and replace it with approved fill material. As alternative to over excavation, soil cement mix should be considered. Based on our experience with similar soil, 4% cement mix should be considered.

The pavement sections provided in this report (for budgeting purposes) have been designed based on methodology from the American Association of State Highway and Transportation Officials' (AASHTO) *Guide for Design of Pavement Structures*, 1993. Summarized below are the subgrade strength parameters, the traffic conditions, and other design parameters and criteria considered in these analyses.

CBR value:	3
Traffic for Light-Duty Pavement:	15,000 ESALs
Traffic for Medium-Duty Pavement:	75,000 ESALs
Reliability:	85 percent
Overall Variance:	0.45
Initial Serviceability:	4.2
Terminal Serviceability:	2.0

Using the above-indicated design parameters, we have estimated pavement section designs as shown in the following table:

Pavement Material	**Compacted Material Thicknesses (Inches)***	
	Standard-Duty (15,000 ESALs)	**Medium-Duty (75,000 ESALs)**
Surface Course Asphalt HMA Superpave - 9.5 mm **	1.5	1.5
Base Course Asphalt HMA Superpave –12.5 mm **	2.0	3.0
Graded Aggregate Base GAB	4.0	8.0
Total Pavement Thickness	7.5	12.5
* Compaction: Level 1 (50 Gyrations) ** Binder Type: PG64-22		

Final determinations of pavement sections to be used at the site may not be possible until the time of actual construction, depending on the sequence of grading and availability of materials, when the subgrade soil conditions become exposed in the various site areas. For planning and pricing considerations, however, it is anticipated that the pavement sections shown for a CBR value of 3 should provide a reasonable estimate of the average pavement sections that will be needed for the site.

The standard-duty pavement section shown in the table above should only be considered for use in areas where traffic will consist primarily of automobiles and light trucks and where any regular use by heavier trucks will be prohibited, such as proposed parking lot areas.

The medium-duty pavement section shown in the table above should be considered for the main site entrances and main service drives that may experience some use by heavier vehicles, including the drive-thru lanes.

It is ECS' opinion that the suggested flexible pavement section would not be suitable for the support of heavy, concentrated wheel loads. Therefore, we recommend that rigid Portland cement concrete pavement sections should be provided for any dumpster storage areas and for any unloading zones for deliveries. The Portland cement concrete pavement section should be at least 6 inches thick and should consist of air-entrained Portland cement concrete having a minimum 28-day compressive strength of 4,000 pounds per square inch (psi). A minimum of 4 inches of compacted dense-graded aggregate subbase (CR-6 or GASB) should be placed beneath all rigid concrete pavements. For any dumpster storage areas, the Portland cement concrete slab area should be large enough to support the dumpster and at least the front wheels of the truck used to unload the dumpster.

The State of Maryland is using pavement materials whose characteristics are based on the SuperPave material specifications. We have provided specifications for Superpave materials in the tables above. Please note that it is important to specify the Compaction Level and the Binder Type for SuperPave materials. All pavement materials and construction should be in accordance with the most current version of the *Standard Specifications for Construction and Materials* of the Maryland Department of Transportation, State Highway Administration (SHA), and any applicable Montgomery County standards.

The pavement sections provided in the tables above were developed for the anticipated in-service traffic conditions only and do not provide an allowance for construction traffic conditions. Therefore, if pavements will be constructed early during site development to accommodate construction traffic, consideration must be given to the construction of heavier pavement sections, capable of accommodating the much heavier loads normally associated with construction traffic, as well as the future in-service traffic. ECS can provide additional design assistance with regard to pavements during the final geotechnical study.

Stormwater Management

Based on the provided information, management of stormwater will be necessary for the project. Specific details regarding the location and depth of the planned SWM facilities were not provided; however, we understand that the facilities will be located within pavement areas and the facility bottoms will be on the order of 12 ft or less below existing grades. The subsurface conditions within the planned SWM facilities were evaluated with Borings P-1 and P-2. The details about the soil strata for each boring can be seen on the soil boring logs in the Appendix.

Laboratory classification per USDA was performed for the recovered soil samples from Borings P-1 and P-2. The results are included in the Appendix.

Infiltration feasibility for the planned facilities was evaluated based on the USDA classifications and field infiltration test, in accordance with Montgomery County standards. Montgomery County requirements indicate that infiltration is considered feasible when the infiltration rate for soils at SWM facility inverts exceeds 0.52 in/hr, which corresponds to a USDA classification of Loam or more granular, provided that groundwater or the presence of an impervious layer is at least 4 ft below the facility invert. Groundwater was not encountered in Borings P-2, which extended to 15 ft below existing grades. Groundwater was encountered in Boring P-1 at a depth of 22 ft below existing grades.

Field infiltration was conducted adjacent to Borings P-1 and P-2. The infiltration pipe was terminated in the Clay layer, above the Clayey Sand layer where infiltration is anticipated. The Clay layer did not infiltrate in the field. However, based upon laboratory USDA classification through gradation analysis by hydrometer, both borings were classified more granular than Loam. Boring P-1 at a depth of 8.5 ft to 10 ft below existing grades was classified as Sandy Loam, with a minimum infiltration rate (in/hr) of 1.02 per USDA. Boring P-2 at a depth of 8.5 ft to 10 ft below existing grades was classified as Sand, with a minimum infiltration rate (in/hr) of 8.27 per USDA. Groundwater was encountered at a depth of 22 ft below existing grades in Boring P-1, and was not encountered in Boring P-2. Therefore, based on the boring results and laboratory classifications, infiltration should generally be considered feasible for SWM facilities represented by P-1 and P-2, at depths below 6 ft. A clay layer was encountered in Boring P-1 at a depth of 12 ft. Therefore, infiltration is considered feasible for inverts between 6 ft and 8 ft below existing grades.

Earthwork Operations

The following paragraphs detail our recommendations regarding subgrade preparation and compaction requirements.

Subgrade Preparation

Subgrade preparation should generally include the stripping of any unsuitable surface materials from the planned structure areas. It is recommended that the stripping of unsuitable surficial materials should extend to a minimum of 10 feet beyond the structure area limits, where feasible.

Subsequent to stripping operations, the exposed subgrade soils in the planned building areas should be examined by a qualified representative of the Geotechnical Engineer. The exposed soils should be thoroughly proofrolled by a vehicle having an axle weight of at least 20 tons, such as a fully-loaded tandem-axle dump truck. This procedure is intended to assist in identifying any localized loose or yielding materials. In the event that any yielding materials are encountered during the proofrolling operations, those subgrade soils should either be thoroughly densified in-place, or undercut to firm ground and replaced with controlled, compacted fill to final subgrade elevations.

Fill Placement

Prior to placement of compacted fill, representative bulk samples (about 50 pounds) should be taken of the proposed fill soils and laboratory tests should be conducted to determine Atterberg limits, natural moisture content, grain-size distribution, and moisture-density relationships for compaction. These test results will be necessary for proper control of construction for new engineered fill.

Upon achieving competent subgrade conditions, the Contractor can place and compact engineered fill to reach final subgrade levels. In general, any materials to be used as structural fill should consist of soil types classified as ML or more granular, in accordance with ASTM D 2487, and should have a Liquid Limit less than 40 and a Plasticity Index less than 15. However, materials used as backfill behind below-grade walls or retaining walls should have classifications of SM, or more granular, in accordance with ASTM D 2487, and should have no more than 30 percent by weight of soil particles finer than the No. 200 sieve. Based on the boring results, most of the on site material should be usable as structural fill.

Finer-grained, more plastic, and organic soil types, if encountered at the site, may be used as fill materials in landscape areas. Any such materials encountered during grading operations should be either stockpiled for later use in landscape fills, or should be placed in approved disposal areas either on-site or off-site.

Prior to the utilization of any on-site or off-site borrow materials, the Geotechnical Engineer should be provided with representative samples in order to determine the suitability of the materials for use as a controlled compacted fill and to develop moisture-density relationships. In order to expedite the earthwork operations, it is recommended that any off-site borrow materials generally should be comprised of SM or more granular soil types.

All structural fill should be placed in loose lifts, which do not exceed 8 inches in thickness, and should be compacted to at least 95 percent of the maximum dry density, as determined by the Standard Proctor Compaction Test (ASTM D 698). Generally, the moisture content of the fill material should be maintained within ±2 percentage points of the optimum moisture content for the fill material, as determined by ASTM D 698. Fill materials in the upper 1 foot of slab and pavement subgrades should be compacted to at least 98 percent of the Standard Proctor maximum dry density. Fill placed in non-structural areas should be compacted to at least 90 percent of the Standard Proctor maximum dry density in order to avoid significant subsidence.

Due to the textural variations of the on-site soils, variations in moisture-density relationships should be anticipated. Such variations must be determined in the field by a qualified representative of the Geotechnical Engineer at the time of construction, so that any necessary changes to fill placement and compaction procedures can be implemented.

The footprint of the proposed building area should be well defined, including the limits of the fill zones at the time of fill placement. Grade controls should be maintained throughout the filling operations. All filling operations should be observed on a full-time basis by a qualified representative of the Geotechnical Engineer to determine that minimum compaction requirements are being achieved.

A minimum of one compaction test per lift should be made per 2,500 square feet of fill lift area, but not fewer than two tests per lift should be made for any lift. The elevations and locations of the field density tests should be clearly identified at the time of fill placement and compaction.

Compaction equipment suitable for the soil types being used as fill should be selected to compact the fill. Theoretically, any equipment type can be used, so long as the required density is achieved. Ideally, a steel drum roller generally will be the most efficient for compaction of granular soil types and for sealing the surface soils, while a sheepsfoot roller or pneumatic-tire roller generally will be most efficient for compaction of cohesive soil types. At the end of each work day, all fill areas should be graded to facilitate surface drainage of any surface runoff associated with precipitation, and should be sealed by use of a smooth-drum roller to limit infiltration of surface water. During placement and compaction of new fill at the beginning of each workday, the Contractor should scarify existing subgrade soils so that a weak plane will not be formed between the new fill and the existing subgrade soils. We recommend that subgrade soils should be scarified to depths of about 4 inches prior to placement of new fill.

Fill materials should not be placed on frozen soils, frost-heaved soils, and/or excessively wet soils. All frozen, frost-heaved, or excessively wet soils should be removed prior to continuation of fill operations. Borrow fill materials should not contain frozen materials at the time of placement. All frozen, frost-heaved, or excavated wet soils should be removed prior to placement of controlled, compacted fill. Moisture contents for excessively wet soils will need to be lowered to the range limits previously discussed.

If any problems are encountered during the earthwork operations, or if site conditions deviate from those indicated by the borings, the Geotechnical Engineer should be notified immediately.

Construction Considerations

The on-site soils contain silt and clay fines that will be sensitive to moisture increases and to construction disturbance. Construction activities in the presence of excessive moisture can lead to softening of the subgrade soils and loss of bearing capacity. Therefore, it will be prudent to schedule earthwork operations during the warmer and drier seasons that generally occur from late spring to early fall. Measures should also be taken to limit site disturbance, especially from rubber-tired heavy construction equipment, and to provide for drainage of surface water from areas being developed.

A firm working surface for the placement of engineered fill should be established prior to construction of new fills. The moisture content of the fill soils at the time of placement should be carefully controlled to ensure that the required compaction effort can be achieved without excessive pumping or movement of the fill mass. In the event that the earthwork operations are accomplished during the cooler and wetter periods of the year, delays and additional costs should be anticipated. At these times, reduction of soil moisture may need to be accomplished by a combination of mechanical manipulation and the use of chemical additives, such as lime or cement, in order to lower moisture contents to levels appropriate for compaction.

As noted in the **Water Level Observations** section of this report, groundwater was encountered in Boring P-1 at a depth of 22 ft below existing grades; however, groundwater is not anticipated to have a significant effect on construction.

Any groundwater encountered during the construction of the structure should be the results of perched water and should be readily managed by interceptor trenches and localized systems of sumps and pumps. Deeper excavation for utilities may encounter ground water and provision for handling water in excavations should be anticipated.

All foundation excavations must be protected to prevent the disturbance of the subgrade materials and to minimize any potential loss of support capacity. Foundation concrete generally should be placed for foundations during the same day that the foundation excavations are made and approved. Should excavating and placing the foundation concrete the same day not be practical, we recommend that a concrete mud mat, 2 to 3 inches thick, be placed to protect the subgrade soils from moisture changes and disturbance. If protection of the soils is not provided, then undercutting of softened or loosened soils may be necessary prior to the placement of reinforcing steel and foundation concrete.

Prior to the placement of any foundation concrete or mud mat, the subgrade soils must be carefully examined and tested by a qualified representative of the Geotechnical Engineer to confirm the availability of the design soil bearing capacity. To minimize disturbance to the subgrade soils during excavation, we recommend that a bucket without scarifying teeth, in addition to hand excavation methods, be used during the final phases of the excavation for the foundations.

Any cuts or excavations associated with building and utility excavations may require forming or bracing, slope flattening, or other physical measures to control sloughing and/or to prevent slope failures. An examination of the applicable OSHA codes and requirements should be made by the appropriate Contractor to ensure that adequate protection of the excavations and trench walls is provided.

The surface soils contain some silt and fine sands and are considered erodible. The Contractor should provide and maintain good site drainage during earthwork operations to help to maintain the integrity of the surface soils. All erosion and sedimentation shall be controlled in accordance with sound engineering practice and current local requirements. Surface water should be directed away from the construction area, and the site should be sloped at gradients of 1 to 2 percent to reduce the potential for ponding water and the subsequent saturation of the surface soils.

CLOSING

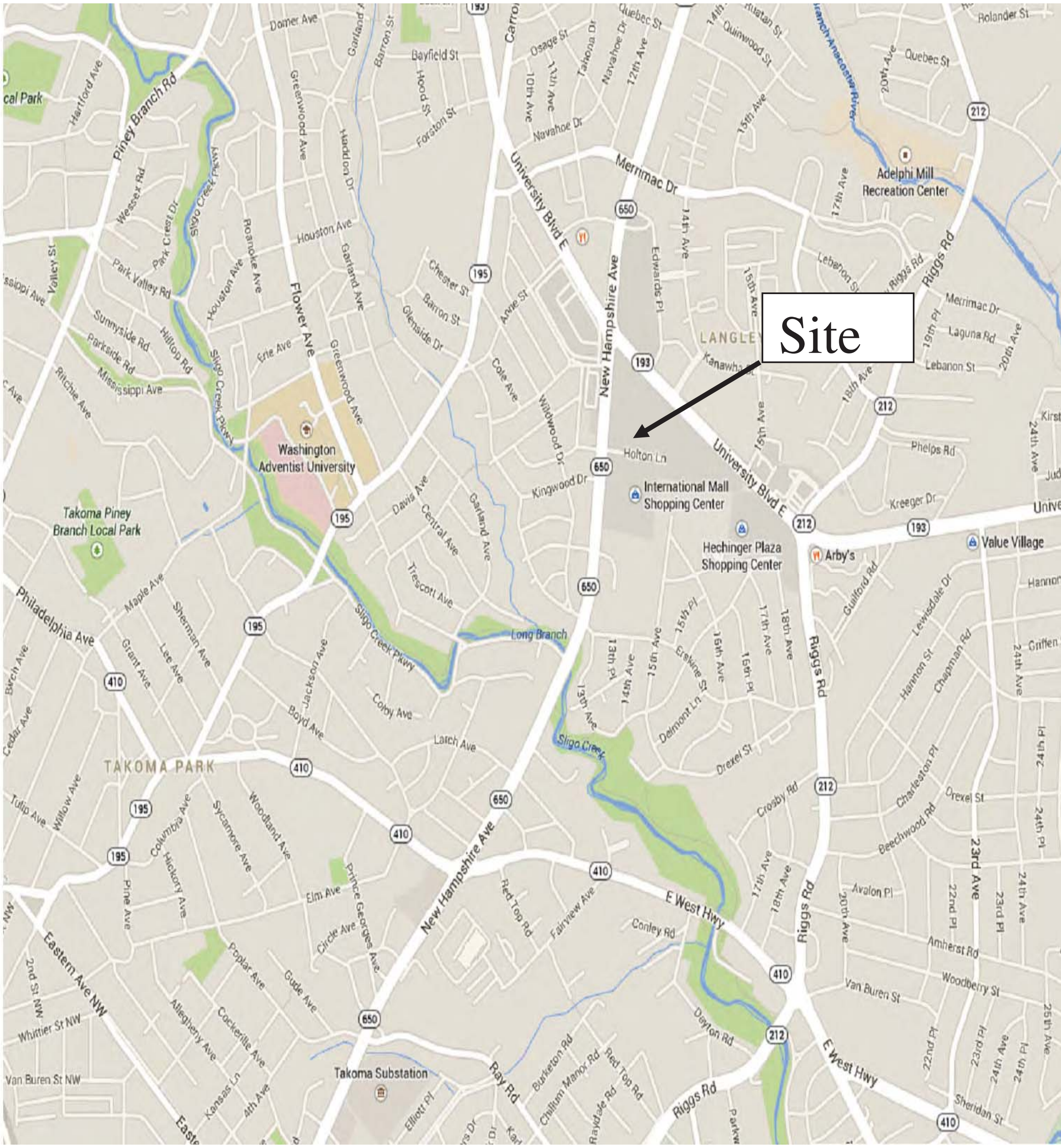
This report has been prepared to provide the Owner and the Design Team with subsurface information and evaluations and recommendations to guide geotechnical-related design and construction for development of the proposed Taco Bell Restaurant in Takoma Park, Maryland. Additional Geotechnical Consulting may be needed as planning and design for the project progress.

The evaluations and recommendations presented in this report are, of necessity, based on the information made available to us at the time of the actual writing of the report and the site conditions, surface and subsurface, that existed at the time the exploratory borings were drilled. Further assumption has been made that the limited exploratory borings, in relation both to the aerial extent of the site and to depth, are representative of general subsurface conditions across the site. If subsurface conditions are encountered that differ significantly from those reported herein, the Geotechnical Engineer should be notified immediately so that the analyses and recommendations presented in this report can be reviewed for validity.

If there are significant changes to the proposed construction from those previously discussed, ECS may need to review the changes to determine whether the evaluations and recommendations of this report will remain valid. ECS should be provided with appropriate plans and other information as project design progresses, so that we can review the information and provide additional geotechnical guidance, as needed. ECS recommends further subsurface investigation at the site prior to final design so that the presence of existing fill materials at the site can be more fully investigated. The Geotechnical Engineer should be retained to prepare, or at least to review, any earthwork specifications to assure that the recommendations of this report have been properly interpreted and included in the construction documents.

APPENDIX

- Site Location Map
- Unified Soil Classification System
- Laboratory Test Results
- Reference Notes for Boring Logs
- Boring Logs
- Boring Location Plan



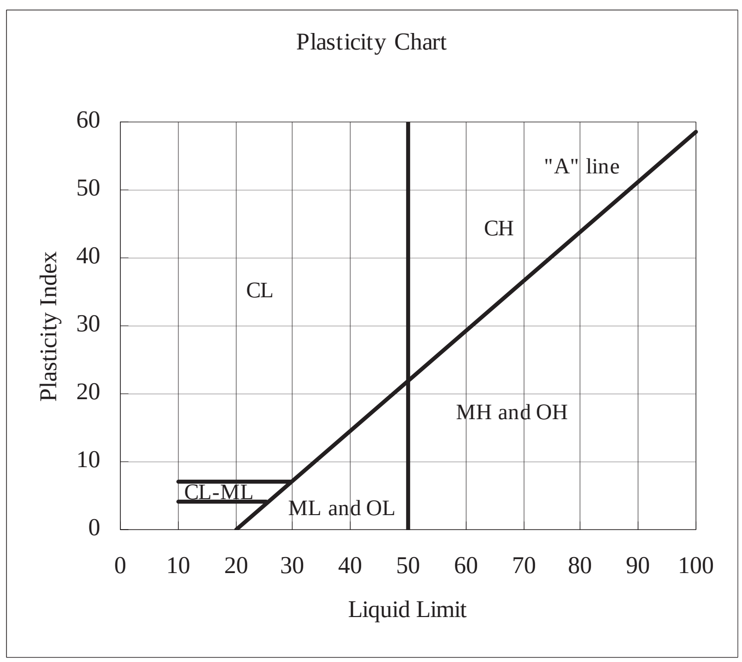
Source: Google Maps
Scale: NTS

NORTH

New Hampshire Avenue & Holton Lane Montgomery County Takoma Park, MD	ECS LLC MID-ATLANTIC	**Figure** Site Location Plan ECS Project 02-7394 August 25, 2014

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

Major Divisions			Group Symbols		Typical Names	Laboratory Classification Criteria		
Coarse-grained soils (More than half of material is larger than No. 200 Sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 percent GW, GP, SW, SP; More than 12 percent GM, GC, SM, SC; 5 to 12 percent Borderline cases requiring dual symbols [b]	$C_u = D_{60}/D_{10}$ greater than 4 $C_c = (D_{30})^2/(D_{10} \times D_{60})$ between 1 and 3	
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM[a]	d	Silty gravels, gravel-sand mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u				
			GC		Clayey gravels, gravel-sand-clay mixtures		Atterberg limits below "A" line or P.I. less than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines		$C_u = D_{60}/D_{10}$ greater than 6 $C_c = (D_{30})^2/(D_{10} \times D_{60})$ between 1 and 3	
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM[a]	d	Silty sands, sand-silt mixtures		Atterberg limits above "A" line or P.I. less than 4	Limits plotting in CL-ML zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u				
			SC		Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils (More than half material is smaller than No. 200 Sieve)	Silts and clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity			
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL		Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH		Inorganic clays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
	Highly Organic soils		Pt		Peat and other highly organic soils			



[a] Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.

[b] Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC,well-graded gravel-sand mixture with clay binder. (From Table 2.16 - Winterkorn and Fang, 1975)

Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3] LL	PL	PI	Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5] Maximum Density (pcf)	Optimum Moisture (%)	CBR Value[6]	Other
B-1												
	S-2	3.50 - 5.00	4.8									
	S-3	6.00 - 7.50	9.5		35	15	20	35.1				
	S-4	8.50 - 10.00	14.3									
	S-5	13.50 - 15.00	18.8									
B-2												
	S-2	3.50 - 5.00	9.4									
	S-3	6.00 - 7.50	7.8									
	S-4	8.50 - 10.00	6.7									
	S-5	13.50 - 15.00	14.7									
P-1												
	S-2	3.50 - 5.00	17.7									
	S-3	6.00 - 7.50	8.5									
	S-4	8.50 - 10.00	9.1									
	S-5	13.50 - 15.00	20.7									
	S-6	18.50 - 20.00	22.9									
	S-7	23.50 - 25.00	18.7									
	S-8	28.50 - 30.00	15.2									
P-2												
	S-1	1.00 - 2.50	15.4									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

Project No. 7394
Project Name: Taco Bell at Langley Park
PM: Zachary L. Adcock
PE: Hasan M. Aboumatar
Printed On: Wednesday, September 24, 2014

ECS MID-ATLANTIC, LLC
1340 Charwood Road, Suite A
Hanover, MD 21076
Phone: (410) 859-4300
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Project Name:	Taco Bell at Langley Park
Project Number	02-7394
Sample ID:	P-1
Depth:	8.5-10 ft
Date:	13 Sep 14

USDA Soil Percentages

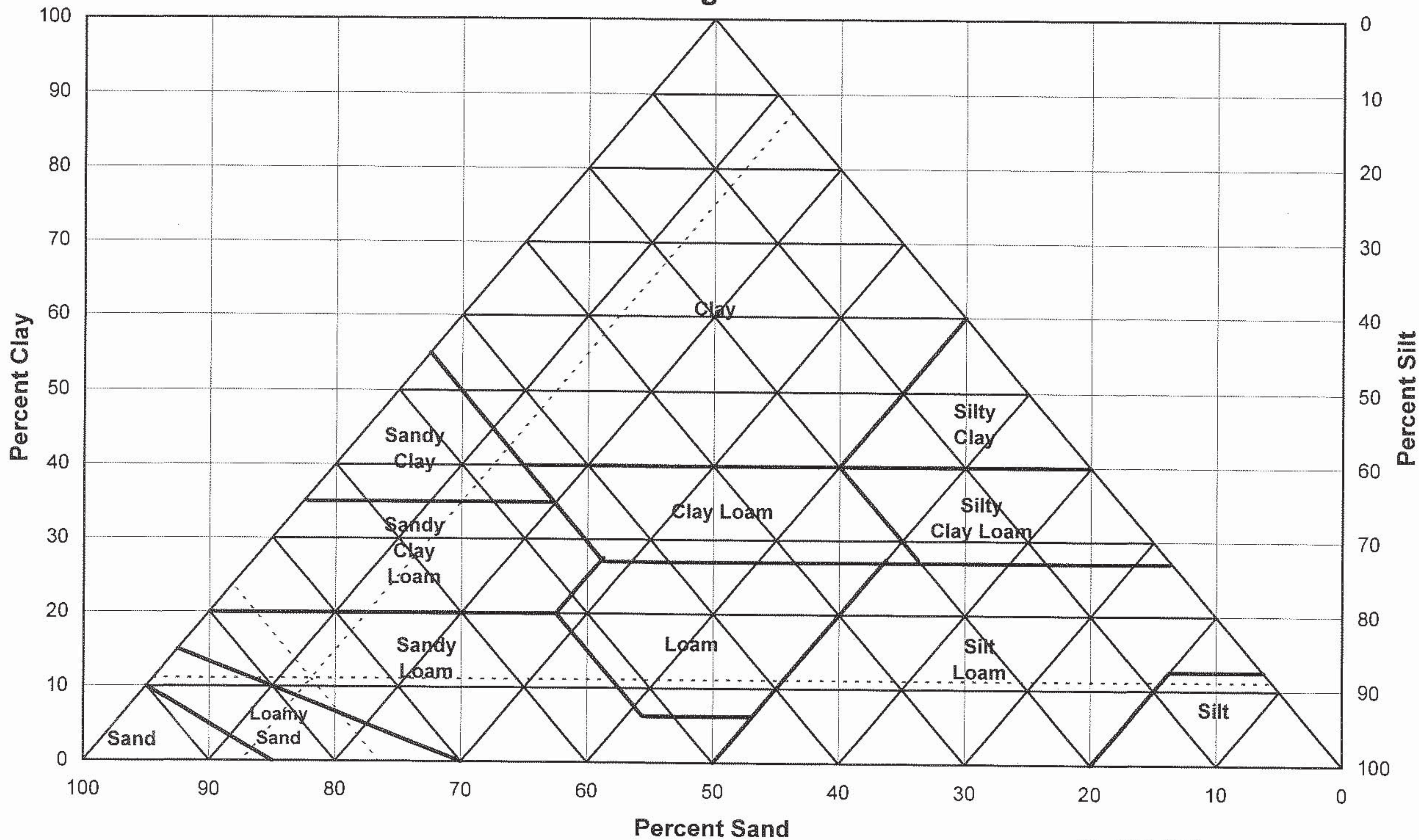
(corrected for gravel)

%Sand	%Silt	%Clay
76.4	12.5	11.1

USDA Class. Sandy Loam

Minimum Infiltration Rate (iph) 1.02

Textural Triangle USDA



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Project Name:	Taco Bell at Langley Park
Project Number	02-7394
Sample ID:	P-2
Depth:	8.5-10 ft
Date:	13 Sep 14

USDA Soil Percentages

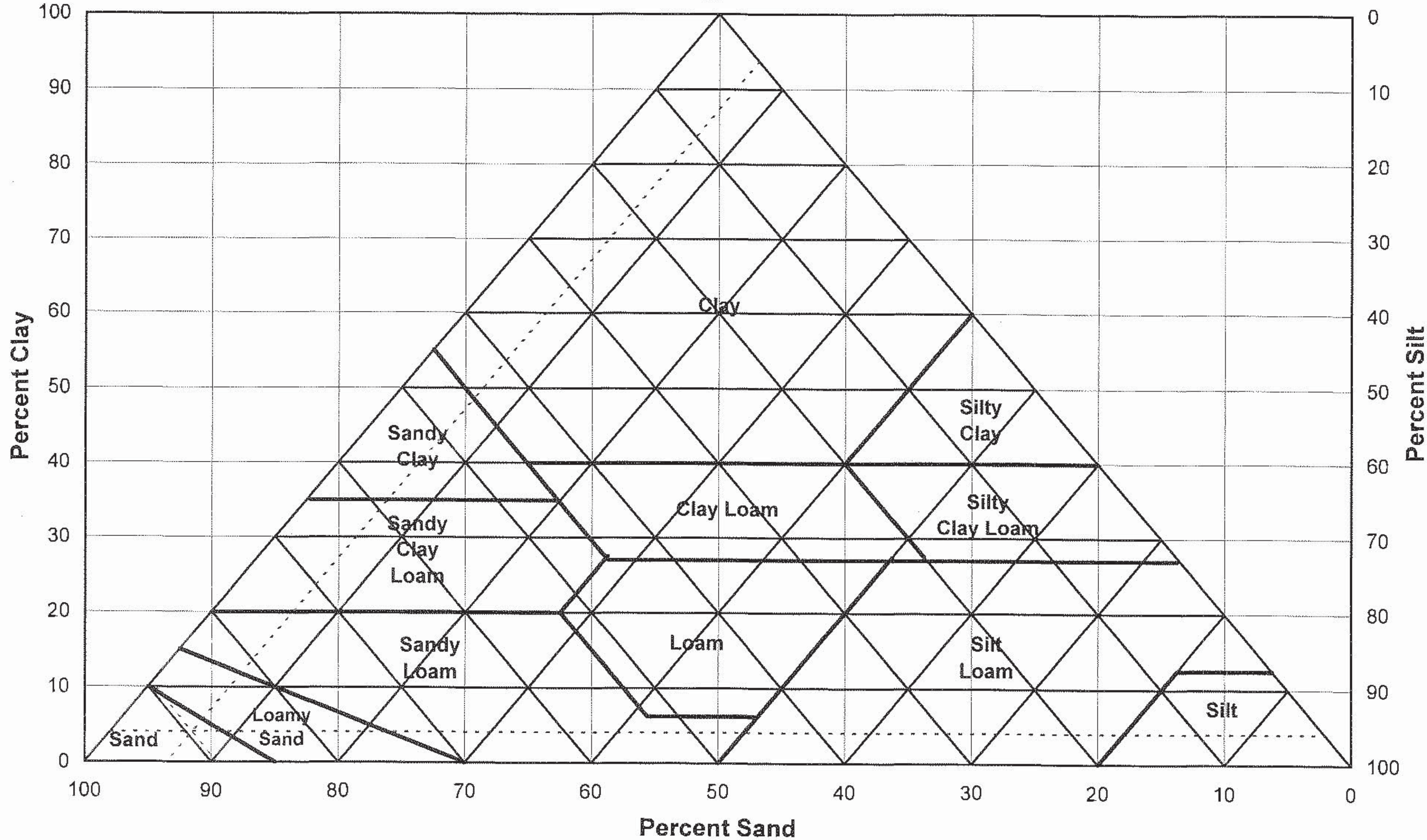
(corrected for gravel)

%Sand	%Silt	%Clay
89.5	6.4	4.1

USDA Class. Sand

Minimum Infiltration Rate (iph) 8.27

Textural Triangle USDA



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