RED

Geotechnical Engineering Report

Chick-fil-A Fircrest #04046

Fircrest, Washington

February 27, 2017

Terracon Project No. 81175006

Prepared for:

Chick-fil-A, Inc.

Irvine, CA

Prepared by:

Terracon Consultants, Inc.

Mountlake Terrace, Washington

February 27, 2017

Chick-fil-A, Inc.
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Attn: Mr. Steve Schwartz
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Re: Geotechnical Engineering Report
Proposed Chick-fil-A #04046 Fircrest
6520 & 6518 19th Street West
Fircrest, Pierce County, Washington
Terracon Project No. 81175006

Dear Mr. Schwartz:

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the above referenced project. This study was performed in general accordance with our master services agreement task order signed January 29, 2017. This report presents the findings of the subsurface exploration program and provides geotechnical recommendations concerning the design and construction of foundations, subsurface drainage, pavement and floor slabs for the proposed project.

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

Sincerely,
Terracon Consultants, Inc.

Brett O'Brien, EIT
Staff Geotechnical Engineer

David A. Baska, Ph.D., P.E.
Department Manager

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GEOTECHNICAL ENGINEERING REPORT
CHICK-FIL-A FIRCREST #04046
6520 & 6518 19th STREET WEST
Tacoma, WASHINGTON, 98466
Terracon Project No. 81175006
February 27, 2017

1.0 INTRODUCTION

This geotechnical engineering report has been completed for the design of the proposed Chick-fil-A #04046 development located at 6520 19th Street West in Tacoma, Washington. The subsurface exploration conducted on the 10th day of February, 2017, consisted of eight (8) geotechnical borings that were advanced to a depths ranging between 6½ and 21½ feet below the existing ground surface at each location. Appendix A of this report includes a Site and Exploration Plan that displays the location of each boring within the project site. Computer generated logs of each boring are also presented in Appendix A.

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

- Soil and groundwater conditions
- Permanent drainage provisions
- Site preparation and earthwork
- Lateral earth pressures
- Foundation design and construction
- Pavement design
- Seismic considerations

The project description, site conditions, and our geotechnical conclusions and design recommendations are in presented the text of this report. Supporting data including field exploration procedures, detailed exploration logs, and results of laboratory testing are presented as appendices.

2.0 PROJECT INFORMATION

2.1 Project Description

Item	Description
Site layout	Refer to the Site Vicinity Map and Site and Exploration Plan (Exhibits A-1 and A-2 in Appendix A).
Proposed structures	A one-story 4,634 square-foot Chick-fil-A restaurant building with associated parking and drive through improvements.

Item	Description
Building construction	Details not provided, but understood to be concrete masonry units (CMU) with steel and/or wood framing with concrete foundations
Finished Floor Elevation	Assumed to be at or near existing site grades.
Maximum loads	Building: Details not provided, but assumed to be: Column Load – 120 kips Load-Bearing Wall Loads – 3,500 plf Maximum Uniform Floor Slab Load – 100 psf
Below grade areas	None anticipated.
Pavements	Asphalt concrete and Portland Cement concrete, standard and heavy duty (assumed).

2.2 Site Location and Description

Item	Description
Location	6520 & 6518 19th Street West, Fircrest, Pierce County, Washington (Pierce County Tax Parcel Nos. 0220116007 & 0220116008)
Existing improvements	A 6,458 square-foot building formerly occupied by a restaurant and a 1,200 square-foot office building.
Current ground cover	Mostly asphalt for parking lot and drive areas, with concrete walkways, planter boxes, and other landscaping features.
Existing topography	The site is relatively flat, with a maximum elevation of roughly 319 feet at its eastern extent sloping gently towards the west reaching a topographic low of approximately 315 feet at the western property boundary.

3.0 SUBSURFACE CONDITIONS

A description of our field exploration procedures and logs of the exploratory borings are presented in Appendix A. Laboratory tests were conducted on select soil samples that were obtained as part of the subsurface exploration program. Laboratory testing information including test descriptions and results are presented in Appendix B.

3.1 Geology

The Tacoma area is generally underlain by a sequence of glacial drift soils consisting of recessional outwash, till, advance outwash, and lacustrine deposits associated with the Vashon

Stade glaciation. Also present are older glacial and interglacial deposits. The following geologic map was reviewed as part of our study:

- "*The Geologic Map of the South Half of the Tacoma Quadrangle, Washington*", by T.J. Walsh, Washington Division of Geology and Earth Resources Open File Report 87-3, published 1987.

Based on the above referenced geologic map, the site is underlain by glacial till soils (Map Unit Q_{dvt}) of the Vashon Stade glacial drift series. Glacial till is generally characterized by a poorly-sorted arrangement of sand and gravel within a silty matrix and, when intact and undisturbed, is typically very dense and overconsolidated. The soils encountered during the subsurface exploration conducted for this geotechnical study were consistent with the mapped geology in the general project vicinity.

3.2 Subsurface Soil Conditions

The subsurface soils at the proposed project site consist primarily of glacial till, which is characteristically comprised of an unsorted assemblage of silty sand and gravel in variable proportions. Some of the glacial till soils appear to have been reworked, as evidenced by a relative decrease in in-situ density and by exhibiting other physical attributes that indicate they were likely placed as fill during previous grading and development efforts. The depth of existing fill is variable across the subject site, with a local maximum occurring in the northwest quadrant where it was encountered at depths of up to 15 feet below existing site grades. In other areas of the site, the southern edge for example, the extent of the fill layer is no more than a couple of feet. The fill soils are generally separated from the underlying dense to very dense, undisturbed glacial till soils by a relatively thin horizon of relict topsoil and/or weathered glacial till. The soils within this weathered zone contain signs of oxidation and traces of organic material.

The characterization and descriptions of the subsurface conditions at the subject site are based on a comprehensive study of the information obtained during the subsurface exploration program that included the advancement of eight geotechnical borings to depths ranging from 6½ feet to a maximum of 21½ feet below the existing ground surface at each respective location. Due to the nature of geotechnical borings, where subsurface information is obtained at discreet locations, it should be understood that variable conditions between borings may exist. Refer to the logs contained in Appendix A of this report for detailed descriptions of the subsurface conditions encountered at each of the boring locations. Stratification boundaries on the logs represent the approximate point of contact between soil types; in-situ, the transition between materials may be gradual.

3.3 Groundwater

Groundwater was not encountered during our geotechnical exploration program. However, perched groundwater seepage, wherein lower permeability layers impede the vertical infiltration of water, should be anticipated in these soils. Groundwater levels fluctuate seasonally depending on time of year, precipitation, and site use, and could be encountered in the future as these conditions change.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

Based on our field exploration program and subsequent study of the subsurface conditions at the proposed project site, it is our opinion that the proposed development is feasible from a geotechnical standpoint contingent on proper design and construction practices. Primary geotechnical considerations that may affect aspects of design and construction are listed below.

- Foundation support of the proposed structure utilizing conventional spread footings is feasible provided that the footing loads are either transmitted directly to undisturbed, native glacial till or by means of properly placed structural fill extending from the undisturbed glacial till to the base of the footing.

- It is anticipated that undocumented fill soils exist in variable thickness within the entire extent of the project site. Support of footings, floor slabs, and pavements on or above existing fill soils presents an inherent risk for the owner that compressible fill or unsuitable material within or buried by the fill will not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill.

- Soil containing traces of organic material was encountered within some of the existing fill and within the relict topsoil and weathered glacial till layers. All subgrade soils that are to be in direct contact with structural elements shall be free of organic and deleterious material.

- The depth of existing fill and underlying relict topsoil at the proposed building location varied from 13 to 18 feet at our exploration locations. As a cost-effective alternative to complete removal of these materials and replacement with structural fill, we recommend ground improvement with aggregate piers.

- The depth of existing fill at our exploration locations in the proposed pavement areas ranged from 1½ to more than 6½ feet. As a cost-effective alternative to complete removal of existing fill, we recommend limiting the depth of removal and replacement in pavement areas to 2 feet unless the underlying relict topsoil layer leads to poor subgrade conditions during proofrolling.

If medium dense native soils are encountered before a depth of 2 feet, all of the existing fill soils should be removed.

- The relatively high proportion of fines content within the glacial till soils tends to decrease permeability thus reducing storm water infiltration potential. Soil with high fines content are also highly sensitive to changes in moisture content and other physical disturbances.

Specific conclusions and recommendations regarding these geotechnical considerations, as well as other geotechnical aspects of design and construction of foundation systems and other earthwork related phases of the project are outlined in the following sections. The recommendations contained in this report are based upon the results of field and laboratory testing (presented in Appendices A and B), engineering analyses, and our current understanding of the proposed project. ASTM and Washington State Department of Transportation (WSDOT) specification codes cited herein respectively refer to the current manual published by the American Society for Testing & Materials and the current edition of the *Standard Specifications for Road, Bridge, and Municipal Construction, (M41-12)*.

4.2 Earthwork

4.2.1 Site Preparation

Preparation for site grading and construction should begin with procedures intended to control surface water runoff and off-site erosion. Existing improvements within the project site (e.g., pavements, concrete flat work, foundations, utilities, etc.) should be removed or relocated, as necessary, in accordance with all local, state, and federal regulations.

4.2.2 Structural Fill

All fill material placed beneath and adjacent to the building should be placed in accordance with the recommendations herein for structural fill. Structural fill is not allowed under foundation elements unless they are designed for the appropriate bearing pressure. Prior to placement, surfaces to receive structural fill should be in a firm and non-yielding condition and the existing fill layer at the site should have been removed. All structural fill should be free of organic material, debris, and other deleterious material. Individual particle size should be less than 4 inches in maximum dimension.

The suitability of soils for use as structural fill is dependent on the gradation and moisture content of the soil when it is placed. As the amount of fines (that soil fraction passing the U.S. No. 200 sieve) increases, soil becomes increasingly sensitive to small changes in moisture content and adequate compaction becomes more difficult, or impossible, to achieve. Generally, soils containing more than about 5 percent fines by weight (based on that soil fraction passing the U.S. No. 4 sieve) cannot be compacted to a firm, non-yielding condition when the moisture content is more than a few percent from optimum. The optimum moisture content yields the greatest soil density under a given compactive effort.

In general, the existing fill soils on-site consist of sand with variable amounts of silt and gravel. These soils are generally considered acceptable for re-use as structural fill from a compositional perspective; however, soils with a greater fraction of silt content will be more sensitive to changes in moisture and may not be practical for re-use as structural fill if the moisture content deviates more than a few percent from optimum. After excavation, we recommend that any stockpiled soil intended to be reused as structural fill be covered with plastic sheeting to prevent deviations from the natural in-situ moisture content of the soil.

Import soils for use as structural fill within and adjacent to the proposed building should consist of "common" or "select" granular material, depending on the weather conditions at the time of placement and the anticipated weather conditions until the fill is protected. These materials are defined below:

- **Select Fill** - "Select" granular fill is recommended for use in wet weather conditions. Select fill should meet the general requirements of Section 9-03.14(1), Gravel Borrow, as presented in the Washington State Department of Transportation (WSDOT) Standard Specifications for Road, Bridge, and Municipal Construction. The percent passing the US No. 200 mesh sieve should, however, be modified from the WSDOT specification to a maximum of 5 percent by weight passing the US No. 200 mesh sieve. Select fill can generally be placed and compacted in a wider variety of weather conditions than Common import fill.

- **Common Fill** - "Common" fill generally consists of lesser quality, more moisture-sensitive soils that can be compacted to a firm and non-yielding condition if near the optimum moisture content. "Common" engineered fill should meet the requirements of Section 9-03.14(3), Common Borrow, as presented in the WSDOT Standard Specifications for Road, Bridge, and Municipal Construction.

The use of other fill types should be reviewed and approved by the engineer. Structural fill should be placed and compacted in horizontal lifts using equipment and procedures conducive to producing the recommended moisture content and densities throughout the fill.

4.2.3 Compaction Requirements

If heavy compaction equipment is utilized (e.g., hoe-pack, or vibro-roller), structural fill should be placed in lifts no greater than 12 inches in loose thickness and compacted to a firm and non-yielding condition. Thinner lifts may be required if lighter, hand-operated equipment is used. Each lift should be compacted to at least 95 percent of the modified Proctor (ASTM D 1557) maximum dry density. This recommended level of compaction should be reduced to 90 to 92 percent of the maximum dry density for subgrade wall backfill and utility trenches below a depth of 2 feet. Moisture contents within 2 percent of the optimum moisture content will likely be required to achieve the recommended relative compaction.

4.2.4 Utility Trenches

Utility trenching should conform to all applicable federal, state, and local regulations, such as OSHA and WISHA, for open excavations.

All trenches should be wide enough to allow for compaction around the haunches of the pipe, or material such as pea gravel (provided this is allowed by the pipe manufacturer) should be used below the spring line of the pipes to eliminate the need for mechanical compaction in this portion of the trenches. We recommend that utility trench excavations be completed using a smooth excavation bucket (without teeth) to reduce the potential for subgrade disturbance. If water is encountered in the excavations, it should be removed prior to fill placement.

Materials, placement and compaction of utility trench backfill should be in accordance with the recommendations presented in Sections 4.2.2 and 4.2.3 of this report. In our opinion, the initial lift thickness should not exceed one foot unless recommended by the manufacturer to protect utilities from damage by compacting equipment. Light, hand-operated compaction equipment in conjunction with thinner fill lift thicknesses may be utilized on backfill placed above utilities if damage resulting from heavier compaction equipment is of concern.

4.2.5 Earthwork Construction Consideration

It is anticipated that excavations for the proposed construction can be accomplished with conventional, heavy-duty, earthmoving equipment. The earthwork contractor should anticipate encountering soils that are highly sensitive to changes in moisture and disturbance, potentially resulting in unstable or inadequate working pad and/or foundation subgrade conditions. In addition, cobbles, boulders and construction debris may be encountered.

If earthwork takes place during freezing conditions, we recommend that the exposed subgrade be allowed to thaw and be re-compacted prior to placing subsequent lifts of structural fill. Alternatively, the frozen soil could be scraped off and wasted to expose unfrozen soil.

The contractor is responsible for designing and constructing stable, temporary excavations as required to maintain stability of both the excavation sides and bottom. Excavations should be sloped or shored in the interest of safety following local, and federal regulations, including current OSHA excavation and trench safety standards.

Construction dewatering is the responsibility of the contractor, who should maintain the excavation and foundation subgrades in a dry condition. Although no groundwater was observed during our exploration program, perched groundwater seepage may be encountered during construction. If construction dewatering is required, we anticipate that dewatering using ditching and sumping methods will be adequate.

4.2.6 Wet Weather / Subgrade Stabilization

We recommend that the earthwork portion of this project be completed during extended periods of dry weather, if possible. If earthwork is completed during the wet season, it may be necessary to take extra precautionary measures to protect subgrade soils. Wet season earthwork may require additional mitigating measures beyond that which would be expected during the drier months. Once subgrades are established, it may be necessary to protect the exposed subgrade soils from construction traffic. Placing quarry spalls or clean pit-run sand and gravel over these areas would further protect the soils from construction traffic. Exposed footing subgrades may require placement of a lean concrete mud mat to protect the bearing surface after excavation.

4.3 Seismic Considerations

We understand the site will be designed to conform to the International Building Code (IBC) which is based on designing for an event with a 2 percent chance of exceedance in 50 years. The following discusses the soil site class and seismic hazard potential at the site:

DESCRIPTION	VALUE
International Building Code Site Classification (IBC) [1, 2]	D
Site Latitude	47.242498° N
Site Longitude	122.524605° W
S_S Spectral Acceleration for a Short Period for Site Class D	1.309g
S_1 Spectral Acceleration for a 1-Second Period for Site Class D	0.514g
F_a Site Coefficient for a Short Period	1.000
F_v Site Coefficient for a 1-Second Period	1.500

[1] In general accordance with the IBC and Table 20.3-1 of ASCE 7 – Chapter 20. Site Class is based on the average characteristics of the upper 100 feet of the subsurface profile.

[2] The IBC and ASCE 7 requires a site soil profile determination extending to a depth of 100 feet for seismic site classification. The current scope was limited to explorations to a maximum depth of 21½ feet. This seismic site class definition is based on the assumption that glacially overridden soils or better materials extend below the bottom of our exploration.

- **Liquefaction** - The liquefaction potential at the site, in response to the design seismic event, is considered to be negligible as the foundation soils are unsaturated.
- **Fault Rupture** – The Tacoma Fault is the closest known fault to the site. If the Tacoma Fault were to rupture, the fault would not likely be observed at the site because the site is more than ¾ miles from the mapped fault zone. Therefore, the possibility of fault rupture occurring at this site is low.

- **Seismic Surcharge** - For backfilled walls, we recommend a uniform seismic lateral surcharge pressure equal to 10H, where H is equal the wall height in feet, and pressure is in pounds per square foot (psf).

4.4 Foundations

The following recommendations take into the account the inherent risk involved with building above existing fill soils based on the assertion that weak, unsuitable and/or compressible material within or buried below the fill could reasonably exist. If constructed upon, the structure would be at risk of sustaining damage as a result of excessive and differential settlement of the substructure that occur as unsuitable soils compress under building loads. As to minimize the aforementioned risk associated with constructing above existing fill soils, the recommended mitigation effort is that all existing fill beneath the footprint of the structure be removed and replaced with structural fill as described in section 4.2 above. Should any lesser mitigation effort be desired at the expense of minimizing risk, additional options can be provided upon request.

4.4.1 Conventional Spread Footing Design Recommendations

The proposed structure can be supported utilizing conventional spread footings if founded on a suitable bearing stratum either consisting of undisturbed, native glacial till or properly compacted structural fill extending to suitable native soils. Based on both our understanding of the proposed development and our study of the geotechnical conditions at the subject site, we anticipate that the required depth of excavation within the building footprint would be on the order of 13 to 18 feet in order to reach suitable subgrade soils for the application of conventional spread footings. Structural fill placed in accordance with section 4.2 of this report may be placed to reestablish desired finished subgrade elevations. We recommend Terracon be retained to provide oversight during initial excavation efforts to verify consistency with the anticipated conditions. Contingent on meeting the prescribed subgrade requirements we present allowable bearing pressures (in kips per square foot) for various spread footing sizes below.

Design Recommendations for
Footings Bearing on Suitable Native Soils

DESCRIPTION	Column	Wall
Bearing material	Native, undisturbed glacial till	
Allowable bearing pressure[1] **< 3 feet in width** **≥ 3 feet in width**	 4 ksf 5 ksf	 4 ksf 5 ksf
Minimum width	24 inches	18 inches
Minimum depth of embedment	18 inches	

Estimated total settlement	<1 inch	<1 inch
Estimated differential settlement	< 1/2 inch over 50 feet	< 1/2 inch over 50 feet
Allowable coefficient of sliding friction[2]	0.3	
Allowable passive earth pressure[2]	275 pcf	

1. Based upon a minimum factor of safety of 3.
2. Based upon a minimum factor of safety of 1.5.

Footings on Structural Fill Placed Over Suitable Subgrade

DESCRIPTION	Column	Wall
Bearing material	Properly compacted structural fill	
Allowable bearing pressure[1]	3 ksf	3 ksf
Minimum width	24 inches	18 inches
Minimum depth of embedment	18 inches	
Estimated total settlement	<1 inch	<1 inch
Estimated differential settlement	< 1/2 inch over 50 feet	< 1/2 inch over 50 feet
Allowable coefficient of sliding friction[2]	0.3	
Allowable passive earth pressure[2]	275 pcf	

1. Based upon a minimum factor of safety of 3.
2. Based upon a minimum factor of safety of 1.5.

The net allowable bearing pressures presented in the tables above may be increased by one-third to resist transient, dynamic loads such as wind or seismic forces.

4.4.2 Ground Improvement Alternative – Aggregate Piers

Implementation of aggregate piers is a method of ground improvement that offers a practical and effective alternative to overexcavation and replacement as a means to facilitate the use conventional spread footings for foundation support. Aggregate piers are columns of crushed stone that, when configured in groups, can provide a significant increase in the density and overall strength of the surrounding soil mass. The increase in density is partly a result of the lateral displacement of the soil that occurs within the subsurface during installation. Relative spacing of the aggregate piers is typically specified by a specialty contractor that accounts for the anticipated building loads in order to determine the level of improvement that is deemed necessary to sustain the required loading. Aggregate piers beneath column spread footings and perimeter strip footings are generally arranged in tighter configurations than beneath areas to receive slab-on-grade. As a general rule of thumb we recommend that aggregate piers extend approximately 5 feet beyond all building limits for adequate support of the structures.

For planning purposes, we recommend an allowable bearing pressure of 4 ksf for footings over aggregate pier improved ground. However, the design bearing pressure should be determined by the ground improvement contractor and reviewed by Terracon.

4.4.3 Foundation Construction Considerations

The base of all foundation excavations should be free of water and unsuitable subgrade soils prior to placing concrete. Concrete should be placed soon after footings are excavated to minimize disturbance of the bearing soils. Should the subgrade soils at the foundation bearing interface become excessively dry, disturbed, saturated, or frozen, the affected soil should be removed. This includes disturbance during placement of reinforcing steel. We recommend that Terracon be retained to observe foundation subgrades prior to placing concrete.

4.5 Slab-on-Grade

Floor slabs for the building should be supported on a capillary break layer placed on competent native soils or structural fill.

4.5.1 Slab-on-Grade Design Recommendations

ITEM	DESCRIPTION
Slab on grade support[1]	Minimum 4 inches of capillary break[2]

1. Upon completion of excavation to subgrade, the subgrade soil moisture content and density should be maintained until construction of the building floor slabs.
2. Crushed rock used for support of floor slabs should meet the general requirements shown in the Table below. The crushed rock should meet WSDOT durability requirements per their standard specifications.

Gradation Requirements for Capillary Break

Sieve Size or Diameter	Percent Passing
1½ inch	100
No. 4	0 to 70
No. 10	0 to 30
No. 100	0 to 5
No. 200	0 to 3

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

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

4.5.2 Slab-on-Grade Construction Considerations

After excavation to subgrade elevation, the base of the excavation is frequently disturbed or altered due to utility excavations, construction traffic, desiccation, or rainfall. As a result, the slab-on-grade subgrade may become unsuitable for floor slab support. At the time of capillary break placement, the subgrade should be evaluated by conducting a proof roll to verify a firm and non-yielding surface. Proof rolling should be completed using heavy equipment under the observation of Terracon. This observer will assess the subgrade conditions prior to capillary break placement. Areas where loose, soft, or disturbed surface soils are observed should be compacted or removed and replaced to the depth of the disturbance as recommended for structural fill.

4.6 Subsurface Drainage Provisions

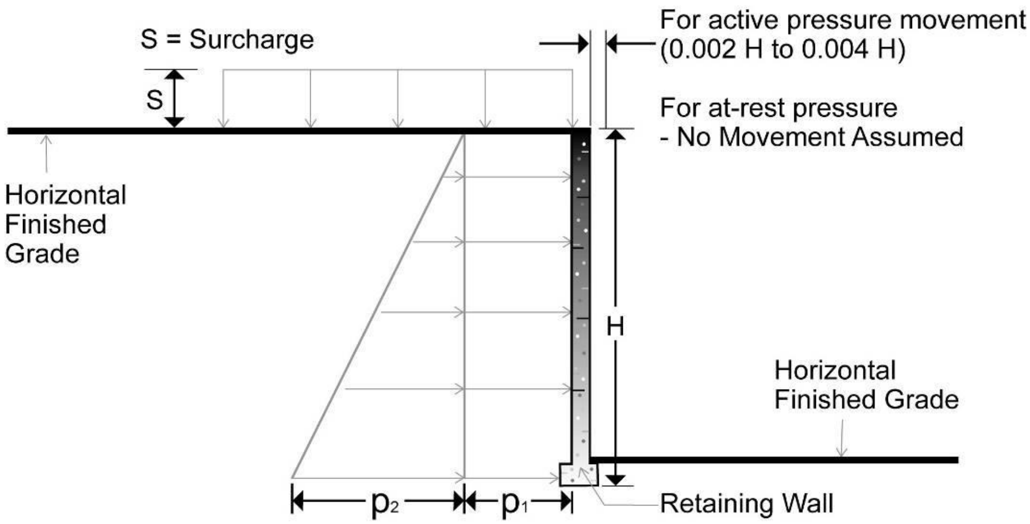
A perimeter footing drain should be provided and consist of a minimum 4-inch diameter heavy walled perforated PVC pipe or equivalent. We recommend that the footing drains have a minimum slope of 0.5 percent, and that the pipe invert is at least 12-inches below the finish floor slab. The pipe should be bedded in at least 4-inches and surrounded by at least 6-inches, of drainage material consisting of ¾-inch washed drain rock. We recommend use of nonwoven filter fabric (Mirafi 140N or equivalent) to wrap the entire pipe and rock assembly. Cleanouts are recommended for the footing drain system.

4.7 Lateral Earth Pressures

4.7.1 Design Recommendations

The lateral earth pressure recommendations herein are applicable to the design of rigid retaining walls subject to slight rotation, such as cantilever, or gravity type concrete walls. These recommendations are not applicable to the design of modular block - geogrid reinforced backfill walls. Recommendations covering these types of wall systems are beyond the scope of services for this assignment. However, we would be pleased to develop recommendations for the design of such wall systems upon request.

Reinforced concrete walls with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to those indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown. Active earth pressure is commonly used for design of free standing cantilever retaining walls and assumes wall movement. The "at rest" condition assumes no wall movement. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls.



EARTH PRESSURE COEFFICIENTS

EARTH PRESSURE CONDITIONS	COEFFICIENT FOR BACKFILL TYPE	EQUIVALENT FLUID DENSITY (pcf)	SURCHARGE PRESSURE, p_1 (psf)	EARTH PRESSURE, p_2 (psf)
Active (Ka)	0.29	35	(0.29)S	(35)H
At-Rest (Ko)	0.46	55	(0.46)S	(55)H
Passive (Kp)	3.4	400	---	---

<u>Applicable conditions to the above include:</u>

- For active earth pressure, wall must rotate about base, with top lateral movements of about 0.002 **H** to 0.004 **H**, where **H** is wall height
- For passive earth pressure to develop, wall must move horizontally to mobilize resistance
- Uniform surcharge, where S is surcharge pressure
- In-situ soil backfill weight a maximum of 120 pcf
- Horizontal backfill, compacted between 92 and 95 percent of modified Proctor maximum dry density
- Loading from heavy compaction equipment not included
- No hydrostatic pressures acting on wall
- No dynamic loading
- No safety factor included in soil parameters
- Ignore passive pressure in frost zone

Backfill placed against structures should consist of granular soils. For the granular values to be valid, the granular backfill must extend out from the base of the wall at an angle of at least 45 and 60 degrees from vertical for the active and passive cases, respectively. To calculate the resistance to sliding, a value of 0.45 should be used as the ultimate coefficient of friction between the footing and the underlying soil.

To aid in reducing the potential for hydrostatic pressure behind walls, we recommend a perimeter drain be installed at the foundation wall footing with a collection pipe leading to a reliable discharge. If adequate drainage is not possible, then combined hydrostatic and lateral earth pressures should be calculated for granular backfill using an equivalent fluid weighing 80 and 90 pcf for active and at-rest conditions, respectively. These pressures do not include the influence of surcharge, equipment or floor loading, which should be added. Heavy equipment should not operate within a distance closer than the exposed height of retaining walls to prevent lateral pressures more than those provided.

4.8 Pavements

4.8.1 Subgrade Preparation

On most project sites, the site grading is accomplished relatively early in the construction phase. Fills are placed and compacted in a uniform manner. However, as construction proceeds, excavations are made into these areas, rainfall and surface water saturates some areas, heavy traffic from concrete trucks and other delivery vehicles disturbs the subgrade and many surface irregularities are filled in with loose soils to improve trafficability temporarily. As a result, the pavement subgrades, initially prepared early in the project, should be carefully evaluated as the time for pavement construction approaches.

We recommend the moisture content and density of the top 12 inches of the subgrade be evaluated and the pavement subgrades be proofrolled within two days prior to commencement of actual paving operations. Areas not in compliance with the required ranges of moisture or density should be moisture conditioned and recompacted. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the materials with properly compacted fills. If a significant precipitation event occurs after the evaluation or if the surface becomes disturbed, the subgrade should be reviewed by qualified personnel immediately prior to paving. The subgrade should be in its finished form at the time of the final review.

4.8.2 Design Considerations

Traffic patterns and anticipated loading conditions were not available at the time that this report was prepared. However, we anticipate that traffic loads will be produced primarily by automobile traffic and occasional delivery and trash removal trucks. The thickness of pavements subjected to heavy truck traffic should be determined using expected traffic volumes, vehicle types, and vehicle loads and should be in accordance with local, city or county ordinances.

Pavement thickness can be determined using AASHTO, Asphalt Institute and/or other methods if specific wheel loads, axle configurations, frequencies, and desired pavement life are provided. Terracon can provide thickness recommendations for pavements subjected to loads other than personal vehicle and occasional delivery and trash removal truck traffic if this information is provided.

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

- Final grade adjacent to parking lots and drives should slope down from pavement edges at a minimum 2%;
- The subgrade and the pavement surface should have a minimum ¼ inch per foot slope to promote proper surface drainage;
- Install pavement drainage surrounding areas anticipated for frequent wetting (e.g., garden centers, wash racks);
- Install joint sealant and seal cracks immediately;
- Seal all landscaped areas in, or adjacent to pavements to reduce moisture migration to subgrade soils;
- Place compacted, low permeability backfill against the exterior side of curb and gutter; and,
- Place curb, gutter and/or sidewalk directly on low permeability subgrade soils rather than on unbound granular base course materials.

4.8.3 Estimates of Minimum Pavement Thickness

As a minimum, we recommend the following typical pavement section be considered for car only areas.

Material	Thickness (inches)	WSDOT
Subgrade	Minimum 24-inches of compacted structural fill	95% of Standard Proctor MMD, -2 to +2% OMC
Aggregate Base	4	WSDOT: 9-03.9(3) Base Course
Asphalt Surface Course	3	WSDOT: 9-03.8(2) ¾-inch HMA WSDOT: 9-03.8(6) ¾-inch Aggregate
Total Pavement Section	7	

As a minimum, we suggest the following typical pavement section be considered for combined car and delivery truck traffic.

Material	Thickness (inches)	WSDOT
Subgrade	Minimum 24-inches of compacted structural fill	98% of Standard Proctor MMD, -2 to +2% OMC
Aggregate Base	6	WSDOT: 9-03.9(3) Base Course
Asphalt Binder Course	2	WSDOT: 9-03.8(2) ¾-inch HMA WSDOT: 9-03.8(6) ¾-inch Aggregate
Asphalt Surface Course	2	WSDOT: 9-03.8(2) ¾-inch HMA WSDOT: 9-03.8(6) ¾-inch Aggregate
Total Pavement Section	10	

The graded aggregate base should be compacted to a minimum of 95 percent of the material's modified Proctor (ASTM D-1557, Method C) maximum dry density. Where base course thickness exceeds 8 inches, the material should be placed and compacted in two or more lifts of equal thickness.

The listed pavement component thicknesses should be used as a guide for pavement systems at the site for the traffic classifications stated herein. These recommendations assume a 20-year pavement design life. If pavement frequencies or loads will be different than that specified Terracon should be contacted and allowed to review these pavement sections.

We recommend a Portland cement concrete (PCC) pavement be utilized in entrance and exit sections, dumpster pads, loading dock areas, or other areas where extensive wheel maneuvering are expected. The dumpster pad should be large enough to support the wheels of the truck which will bear the load of the dumpster. We recommend a minimum of 5 inches of PCC underlain by 4 inches of crushed aggregate base material. Although not required for structural support, the base course layer is recommended to help reduce potentials for slab curl, shrinkage cracking, and subgrade "pumping" through joints. Proper joint spacing will also be required to prevent excessive slab curling and shrinkage cracking. All joints should be sealed to prevent entry of foreign material and dowelled where necessary for load transfer.

Portland cement concrete should be designed with proper air-entrainment and have a minimum compressive strength of 4,000 psi after 28 days of laboratory curing. Adequate reinforcement and number of longitudinal and transverse control joints should be placed in the rigid pavement in accordance with ACI requirements. The joints should be sealed as soon as possible (in accordance with sealant manufacturer's instructions) to minimize infiltration of water into the soil.

4.8.4 Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section.

We recommend drainage be included at the bottom of the crushed aggregate base layer at the storm structures to aid in removing water that may enter this layer. Drainage could consist of small diameter weep holes excavated around the perimeter of the storm structures. The weep holes should be excavated at the elevation of the crushed aggregate base and soil interface. The excavation should be covered with No. 57 stone which is encompassed in Mirafi 140 NL or approve equivalent which will aid in reducing fines from entering the storm system.

4.8.5 Pavement Maintenance

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

5.0 GENERAL COMMENTS

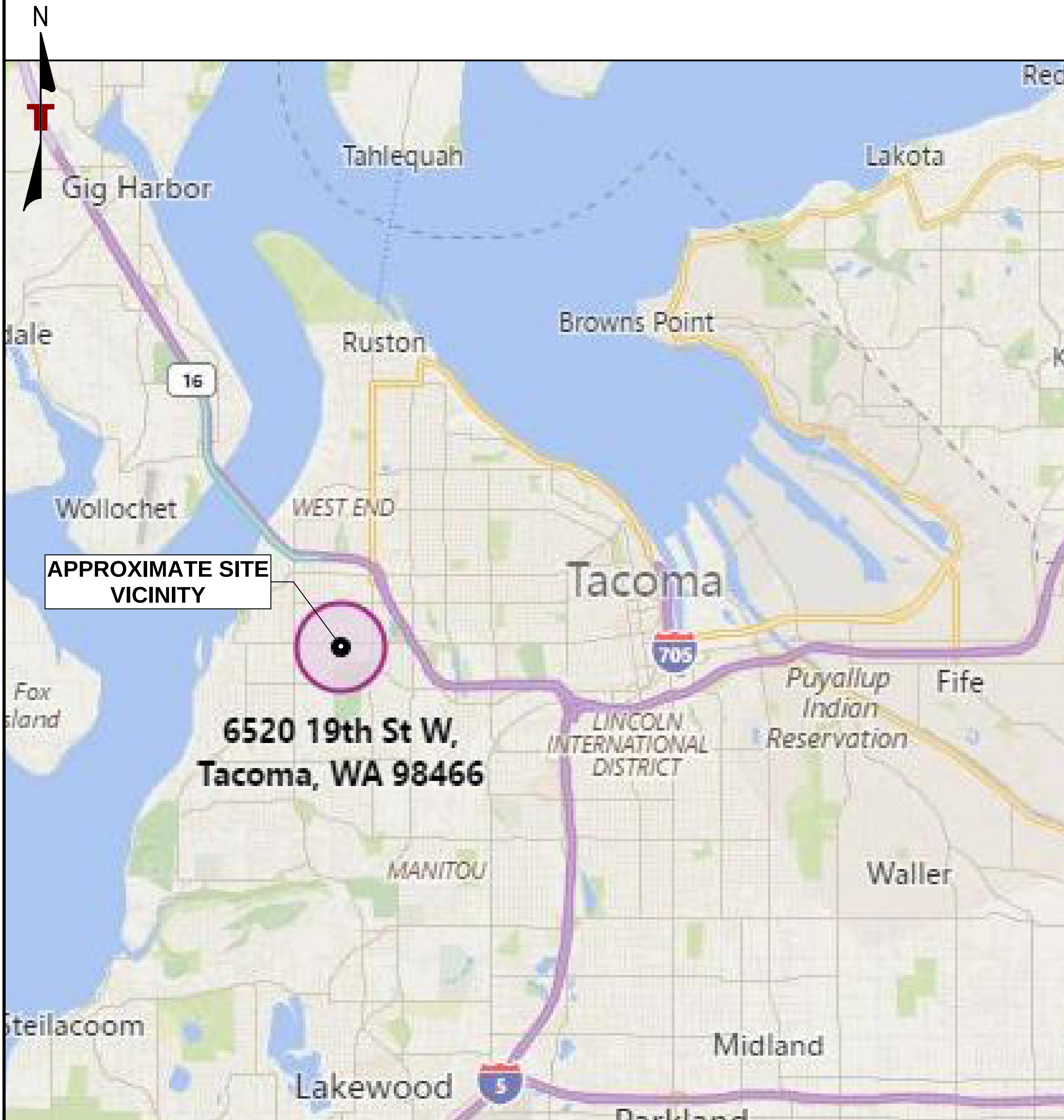
Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during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

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

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

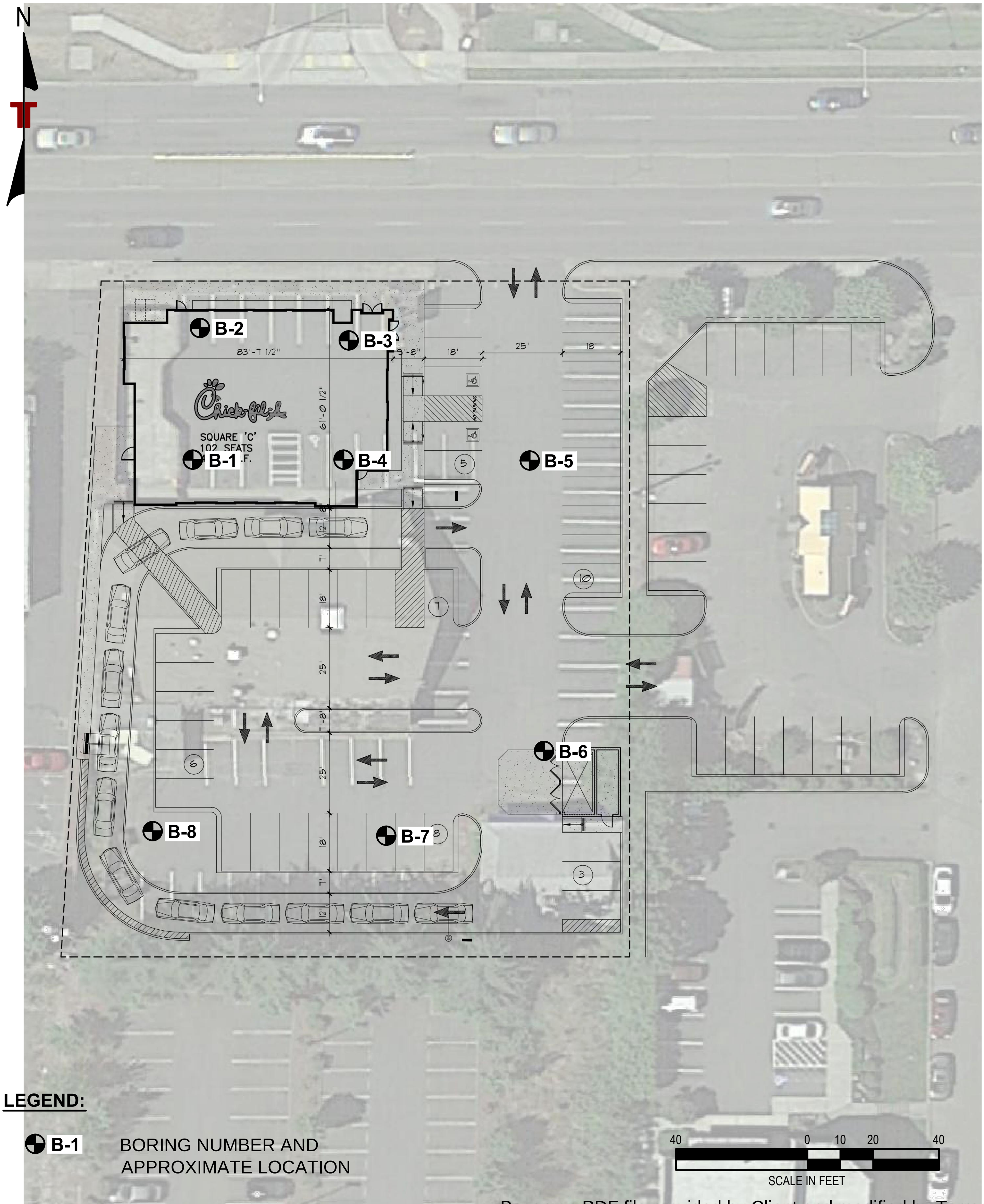
Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION



Basemap PDF file provided by BING Maps and modified by Terracon.
Map data ©2015 BING

Project Mngr: DAB	Project No. 81175006	Terracon Consulting Engineers and Scientists	**SITE VICINITY MAP**	EXHIBIT
Drawn By: B. O'Brien	Scale: AS SHOWN		CFA #04046 Fircrest FSU	A-1
Checked By: DAB	File No. Exhibit A-1.dwg	21905 64th Avenue W., Ste 100 Mountlake Terrace, WA 98043	6520 19th St West	
Approved By: DAB	Date: February 2017	PH. (425) 771-3304 FAX. (425) 771-3549	Tacoma, Washington	



Basemap PDF file provided by Client and modified by Terracon.
Map data ©2015 Google

Project Mngr: P. Davis	Project No. 81175006	Terracon Consulting Engineers and Scientists	**SITE AND EXPLORATION PLAN**
Drawn By: B. O'Brien	Scale: AS SHOWN	21905 64th Avenue W., Ste 100 Mountlake Terrace, WA 98043	CFA #04046 Fircrest FSU
Checked By: DAB	File No. Exhibit A-2.dwg	PH. (425) 771-3304 FAX. (425) 771-3549	6520 19th St West
Approved By: DAB	Date: February 2017		Tacoma, Washington

EXHIBIT A-2

Field Exploration Description

Our field exploration for this project included eight geotechnical borings completed on February 10, 2017. The approximate exploration locations are shown on the Site and Exploration Plan, Exhibit A-2. Boring elevations were estimated from a site topographic map provided by the client, and should be considered accurate to the methods used. Boring locations were determined using a hand held GPS device. If precise locations and elevations are required, we recommend that the ground surface at the four drilling locations be surveyed.

Boring Procedures

The borings were drilled by an independent drilling company working under subcontract to Terracon. The borings were advanced with a hollow-stem auger using a truck-mounted drill rig. An engineer from our firm continuously observed the borings, logged the subsurface conditions encountered, and obtained representative soil samples. All samples were stored in moisture-tight containers and transported to our laboratory for testing.

Throughout the drilling operation, soil samples were obtained at 2.5- to 5-foot depth intervals by means of the Standard Penetration Test (ASTM: D-1586) using an automatic SPT hammer. This testing and sampling procedure consists of driving a standard 2-inch outside diameter steel split spoon sampler 18 inches into the soil with a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler through each 6-inch interval is recorded, and the total number of blows struck during the final 12 inches is reported as the Standard Penetration Resistance, or "blow count" (N value). If a total of 50 blows is struck within any 6-inch interval, the driving is stopped and the blow count is reported as 50 blows for the actual penetration distance. The resulting Standard Penetration Resistance values indicate the relative density of granular soils and the relative consistency of cohesive soils.

Note that a greater efficiency is typically achieved with the automatic SPT hammer compared to the conventional safety hammer operated with a cathead and rope. Published correlations between the SPT values and soil properties are based on the lower efficiency cathead and rope method. This higher efficiency affects the standard penetration resistance blow count (N) value by increasing the penetration per hammer blow over what would be obtained using the cathead and rope method. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

The enclosed boring logs describe the vertical sequence of soils and materials encountered in each boring, based primarily upon our field classifications. Where a soil contact was observed to be gradational, our logs indicate the average contact depth. Where a soil type changed between sample intervals, we inferred the contact depth. Our logs also graphically indicate the blow count, sample type, and approximate depth of each soil sample obtained from the boring. If groundwater was encountered in a borehole, the approximate groundwater depths, and date of observation, are depicted on the log.

BORING LOG NO. B-1

PROJECT: CFA #04046 Fircrest FSU

CLIENT: Chick-fil-A Irvine, CA

SITE: 6520 19th St West Tacoma, Washington

Steve Schwartz

LOCATION See Exhibit A-2

Latitude: 47.242501° Longitude: -122.524788°

Approximate Surface Elev: 318 (Ft.) +/-

DEPTH	DESCRIPTION	ELEVATION (Ft.)
0.2	**ASPHALT**, approximately 2-inch thickness	318+/-
	SILTY GRAVELLY SAND (SM), gray to brown, loose, moist **(FILL)** trace organics in cuttings trace gravel easy drilling	
14.0		304+/-
	SILTY SAND (SM), trace gravel, dark brown, medium dense, moist **(RELICT TOPSOIL))**	
16.5		301.5+/-
	SILTY SAND WITH GRAVEL (SM), light brown, very dense, moist **(GLACIAL TILL)**	
21.5		296.5+/-
	Boring Terminated at 21.5 Feet	

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
5		X	8	5-4-3 N=7		
10		X	12	7-5-4 N=9	13	18
15		X	12	6-6-6 N=12		
20		X	14	21-34-46 N=80	6	31

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

Hammer Type: Automatic

Advancement Method:
HSA

Abandonment Method:
Backfilled with bentonite
Surface capped with concrete

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were measured in the field using an engineer's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 2/10/2017	Boring Completed: 2/10/2017
Drill Rig: Mobile B-59	Driller: Holocene
Project No.: 81175006	Exhibit: A-4

BORING LOG NO. B-2

PROJECT: CFA #04046 Fircrest FSU

CLIENT: Chick-fil-A Irvine, CA

SITE: **6520 19th St West Tacoma, Washington**

Steve Schwartz

LOCATION See Exhibit A-2

Latitude: 47.242616° Longitude: -122.524787°

Approximate Surface Elev: 318 (Ft.) +/-

DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
0.3	**ASPHALT**, appriximately 3-inch thickness	318+/-							
	SILTY SAND WITH GRAVEL (SM), brown, medium dense, moist **(FILL)**								
			5		X	3	10-13-14 N=27	8	18
			10		X	7	10-14-13 N=27		
	hard drilling								
15.0		303+/-							
	SILTY SAND WITH GRAVEL, trace organics, orange to brown, loose, moist, oxidized **(RELICT TOPSOIL)**		15		X	10	5-4-4 N=8		
18.0		300+/-							
	SILTY SAND, trace gravel, brown to gray, medium dense, moist **(WEATHERED GLACIAL TILL)**		20		X	14	10-11-10 N=21		
21.5		296.5+/-							
	Boring Terminated at 21.5 Feet								

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

Hammer Type: Automatic

Advancement Method:
HSA

Abandonment Method:
Backfilled with bentonite
Surface capped with concrete

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were measured in the field using an engineer's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 2/10/2017	Boring Completed: 2/10/2017
Drill Rig: Mobile B-59	Driller: Holocene
Project No.: 81175006	Exhibit: A-5

BORING LOG NO. B-3

PROJECT: CFA #04046 Fircrest FSU

CLIENT: Chick-fil-A Irvine, CA

SITE: 6520 19th St West Tacoma, Washington

Steve Schwartz

LOCATION See Exhibit A-2

Latitude: 47.242608° Longitude: -122.524603°

Approximate Surface Elev: 317 (Ft.) +/-

DEPTH	Material Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
0.2	**ASPHALT**, approximately 2-inch thickness	317+/-							
	SILTY SAND WITH GRAVEL (SM), gray brown, loose to medium dense, moist **(FILL)**								
			5		X	8	2-3-4 N=7		
			10		X	13	8-9-8 N=17		
15.0		302+/-							
	SANDY SILT (SM), with fibrous organics and trace gravel, orange brown, loose, oxidized and stained, moist **(RELICT TOPSOIL)**		15		X	11	2-2-2 N=4	24	
17.5		299.5+/-							
	POORLY GRADED SAND WITH SILT (SP-SM), trace gravel and organics, gray to brown, medium dense, stratified, moist, alternating layers of medium to coarse clean sand and silty sand **(RECESSIONAL OUTWASH)**								
			20		X	15	11-10-7 N=17		
21.5		295.5+/-							
	Boring Terminated at 21.5 Feet								

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

Hammer Type: Automatic

Advancement Method:
HSA

Abandonment Method:
Backfilled with bentonite
Surface capped with concrete

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were measured in the field using an engineer's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 2/10/2017	Boring Completed: 2/10/2017
Drill Rig: Mobile B-59	Driller: Holocene
Project No.: 81175006	Exhibit: A-6

BORING LOG NO. B-4

PROJECT: CFA #04046 Fircrest FSU

CLIENT: Chick-fil-A Irvine, CA

SITE: 6520 19th St West Tacoma, Washington

Steve Schwartz

LOCATION See Exhibit A-2

Latitude: 47.242498° Longitude: -122.524605°

Approximate Surface Elev: 317 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
0.2	**ASPHALT**, approximately 1-1/2 inch thickness	317+/-							
	SILTY SAND (SM), trace gravel, light brown to gray, medium dense, moist to wet **(FILL)**								
			5		X	6	5-6-8 N=14		
10.0		307+/-							
	SILTY SAND (SM), trace gravel and organics, brown, medium dense, moist **(RELICT TOPSOIL)**		10		X	11	7-7-6 N=13		
13.0		304+/-							
	GRAVELLY SAND WITH SILT (SM), gray, very dense, moist **(GLACIAL TILL)**		15		X	15	7-24-32 N=56		
16.5		300.5+/-							
	Boring Terminated at 16.5 Feet								

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

Hammer Type: Automatic

Advancement Method:
HSA

Abandonment Method:
Backfilled with bentonite
Surface capped with concrete

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were measured in the field using an engineer's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 2/10/2017	Boring Completed: 2/10/2017
Drill Rig: Mobile B-59	Driller: Holocene
Project No.: 81175006	Exhibit: A-7

BORING LOG NO. B-5

PROJECT: CFA #04046 Fircrest FSU	**CLIENT: Chick-fil-A Irvine, CA**
SITE: 6520 19th St West Tacoma, Washington	**Steve Schwartz**

LOCATION See Exhibit A-2

Latitude: 47.242498° Longitude: -122.524376°

Approximate Surface Elev: 316 (Ft.) +/-

GRAPHIC LOG	DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
	0.2	**ASPHALT**, approximately 2-inch thickness	316+/-							
		SILTY SAND WITH GRAVEL, light brown, medium dense, moist **(FILL)**								
				5		X	13	8-8-11 N=19		
	6.5		309.5+/-							

Boring Terminated at 6.5 Feet

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

Hammer Type: Automatic

Advancement Method:
HSA

Abandonment Method:
Backfilled with bentonite
Surface capped with concrete

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were measured in the field using an engineer's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 2/10/2017	Boring Completed: 2/10/2017
Drill Rig: Mobile B-59	Driller: Holocene
Project No.: 81175006	Exhibit: A-8

BORING LOG NO. B-6

PROJECT: CFA #04046 Fircrest FSU

CLIENT: Chick-fil-A Irvine, CA

SITE: 6520 19th St West Tacoma, Washington

Steve Schwartz

LOCATION See Exhibit A-2

Latitude: 47.242251° Longitude: -122.524333°

Approximate Surface Elev: 316 (Ft.) +/-

DEPTH	Material Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
0.2	**ASPHALT**, approximately 2-inch thickness	316+/-							
4.0	**SILTY SAND WITH GRAVEL (SM)**, light brown, moist **(FILL)**	312+/-							
6.5	**SILTY SAND WITH GRAVEL (SM)**, orange brown, medium dense, moist **(WEATHERED GLACIAL TILL)**	309.5+/-	5			11	5-7-10 N=17	7	29

Boring Terminated at 6.5 Feet

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

Hammer Type: Automatic

Advancement Method:
HSA

Abandonment Method:
Backfilled with bentonite
Surface capped with concrete

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were measured in the field using an engineer's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 2/10/2017	Boring Completed: 2/10/2017
Drill Rig: Mobile B-59	Driller: Holocene
Project No.: 81175006	Exhibit: A-9

BORING LOG NO. B-7

PROJECT: CFA #04046 Fircrest FSU

CLIENT: Chick-fil-A
Irvine, CA

SITE: 6520 19th St West
Tacoma, Washington

Steve Schwartz

LOCATION See Exhibit A-2

Latitude: 47.242176° Longitude: -122.524581°

Approximate Surface Elev: 317 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
0.2	**ASPHALT**, approximately 2-inch thickness	317+/-							
4.0	**SILTY SAND WITH GRAVEL (SM)**, light brown, moist **(FILL)**	313+/-							
5.5	**SILTY SAND (SM)**, trace gravel, brown to orange brown, loose, moist **(RELICT TOPSOIL)**	311.5+/-	5						
6.5	**SILTY SAND WITH GRAVEL (SM)**, orange brown, medium dense, moist **(GLACIAL TILL)**	310.5+/-			X	3	1-6-19 N=25		

Boring Terminated at 6.5 Feet

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

Hammer Type: Automatic

Advancement Method:
HSA

Abandonment Method:
Backfilled with bentonite
Surface capped with concrete

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were measured in the field using an engineer's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 2/10/2017	Boring Completed: 2/10/2017
Drill Rig: Mobile B-59	Driller: Holocene
Project No.: 81175006	Exhibit: A-10

BORING LOG NO. B-8

PROJECT: CFA #04046 Fircrest FSU	CLIENT: Chick-fil-A Irvine, CA
SITE: 6520 19th St West Tacoma, Washington	Steve Schwartz

LOCATION See Exhibit A-2

Latitude: 47.242175° Longitude: -122.524842°

Approximate Surface Elev: 318 (Ft.) +/-

DEPTH		ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
0.2	**ASPHALT**, approximately 2-inch thickness	318+/-							
1.5	**SILTY SAND WITH GRAVEL (SM)**, light brown, moist **(FILL)**	316.5+/-							
5.0	**SILTY SAND WITH GRAVEL (SM)**, orange brown, medium dense, moist **(WEATHERED GLACIAL TILL)**	313+/-	5						
6.5	**SILTY SAND WITH GRAVEL (SM)**, gray, very dense, moist **(GLACIAL TILL)**	311.5+/-			X	12	21-31-28 N=59	8	30

Boring Terminated at 6.5 Feet

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

Hammer Type: Automatic

Advancement Method:
HSA

Abandonment Method:
Backfilled with bentonite
Surface capped with concrete

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were measured in the field using an engineer's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 2/10/2017	Boring Completed: 2/10/2017
Drill Rig: Mobile B-59	Driller: Holocene
Project No.: 81175006	Exhibit: A-11

APPENDIX B

LABORATORY TESTING

Laboratory Testing

Samples retrieved during the field exploration were taken to the laboratory for further observation by the project geotechnical engineer and were classified in accordance with the Unified Soil Classification System (USCS) described in Appendix C. At that time, the field descriptions were confirmed or modified as necessary and an applicable laboratory testing program was formulated to determine index properties of the subsurface materials.

Laboratory tests were conducted on selected soil samples and the test results are presented in this appendix and/or on the exploration logs. The laboratory test results were used for the geotechnical engineering analyses, and the development of foundation and earthwork recommendations. Laboratory tests were performed in general accordance with the applicable ASTM, local, or other accepted standards.

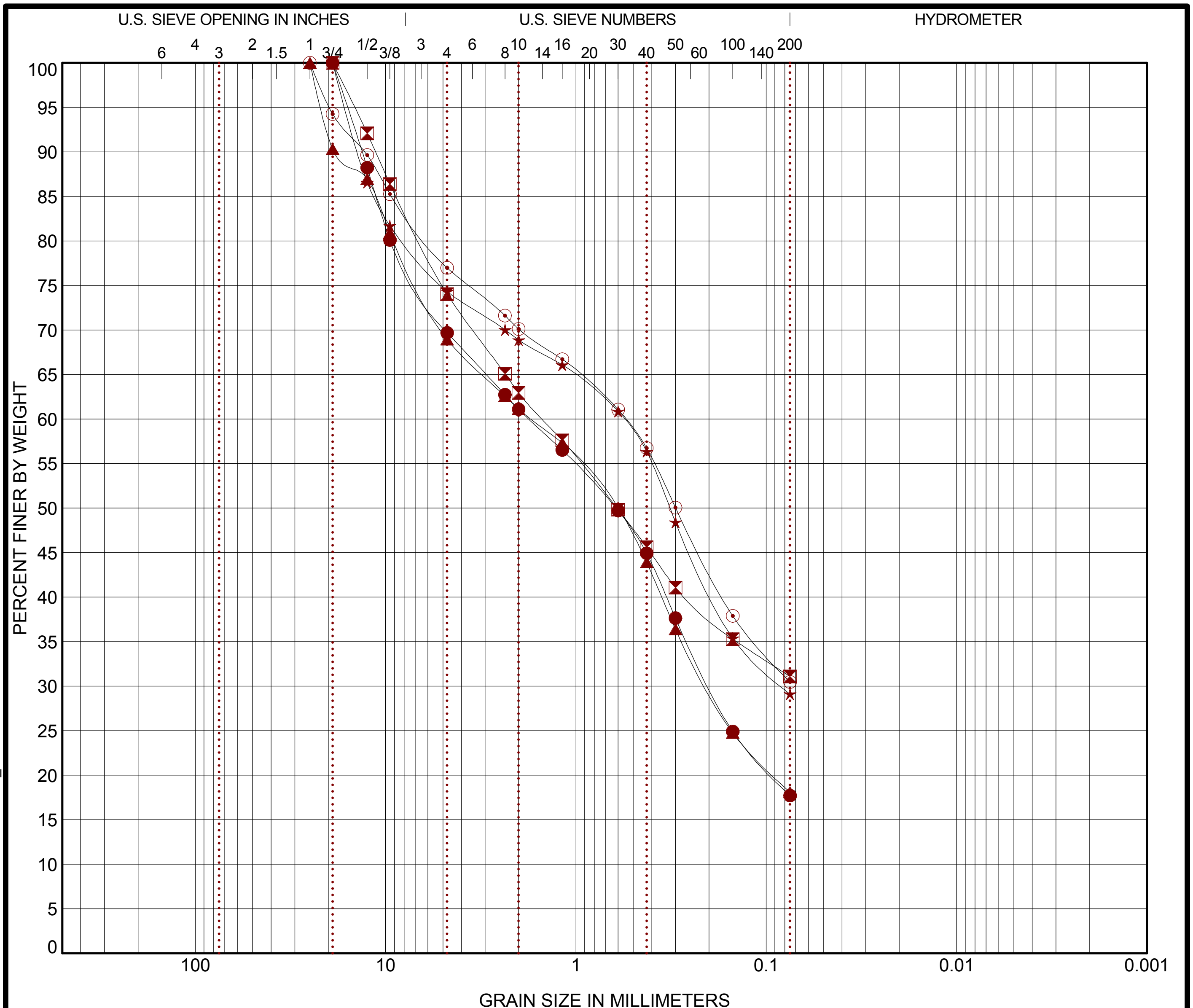
Selected soil samples obtained from the site were tested for the following index properties:

- In-situ Water Content
- Grain-size Distribution

Graphical results of the grain-size distribution tests are included in this appendix.

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID	Depth	AASHTO Classification	LL	PL	PI	Cc	Cu
● B-1	10 - 11.5	SILTY GRAVELLY SAND (SM)					
⧗ B-1	20 - 21.5	SILTY SAND with GRAVEL (SM)					
▲ B-2	5 - 6.5	SILTY GRAVELLY SAND (SM)					
★ B-6	5 - 6.5	SILTY SAND with GRAVEL (SM)					
⊙ B-8	5 - 6.5	SILTY SAND with GRAVEL (SM)					

Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Clay
● B-1	10 - 11.5	19	1.763	0.198		30.3	52.0	17.7	
⧗ B-1	20 - 21.5	19	1.496			26.0	42.9	31.1	
▲ B-2	5 - 6.5	25	1.714	0.205		31.1	50.9	18.1	
★ B-6	5 - 6.5	19	0.561	0.083		25.7	45.2	29.1	
⊙ B-8	5 - 6.5	25	0.551			23.0	46.5	30.5	

PROJECT: CFA #04046 Fircrest FSU

SITE: 6520 19th St West
Tacoma, Washington

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

PROJECT NUMBER: 81175006

CLIENT: Chick-fil-A
Irvine, CA

EXHIBIT: B-2

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: AASHTO-2 81175006.GPJ TERRACON_DATATEMPLATE.GDT 2/27/17

APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon – 1-$^{3}/_{8}$" I.D., 2" O.D., unless otherwise noted	HS:	Hollow Stem Auger
ST:	Thin-Walled Tube - 3" O.D., unless otherwise noted	PA:	Power Auger
RS:	Ring Sampler - 2.42" I.D., 3" O.D., unless otherwise noted	HA:	Hand Auger
DB:	Diamond Bit Coring - 4", N, B	RB:	Rock Bit
BS:	Bulk Sample or Auger Sample	WB:	Wash Boring or Mud Rotary

The number of blows required to advance a standard 2-inch O.D. split-spoon sampler (SS) the last 12 inches of the total 18-inch penetration with a 140-pound hammer falling 30 inches is considered the “Standard Penetration” or “N-value”.

WATER LEVEL MEASUREMENT SYMBOLS:

WL:	Water Level	WS:	While Sampling	N/E:	Not Encountered
WCI:	Wet Cave in	WD:	While Drilling		
DCI:	Dry Cave in	BCR:	Before Casing Removal		
AB:	After Boring	ACR:	After Casing Removal		

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. Groundwater levels at other times and other locations across the site could vary. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels may not be possible with only short-term observations.

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

CONSISTENCY OF FINE-GRAINED SOILS

Unconfined Compressive Strength, Qu, psf	Standard Penetration or N-value (SS) Blows/Ft.	Consistency
< 500	0-1	Very Soft
500 – 1,000	2-3	Soft
1,001 – 2,000	4-6	Medium Stiff
2,001 – 4,000	7-12	Stiff
4,001 – 8,000	13-26	Very Stiff
8,000+	26+	Hard

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Standard Penetration or N-value (SS) Blows/Ft.	Ring Sampler (RS) Blows/Ft.	Relative Density
0 – 3	0-6	Very Loose
4 – 9	7-18	Loose
10 – 29	19-58	Medium Dense
30 – 49	59-98	Dense
50+	99+	Very Dense

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other Constituents	Percent of Dry Weight
Trace	< 15
With	15 – 30
Modifier	> 30

GRAIN SIZE TERMINOLOGY

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

RELATIVE PROPORTIONS OF FINES

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

PLASTICITY DESCRIPTION

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

UNIFIED SOIL CLASSIFICATION SYSTEM

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

[A] Based on the material passing the 3-in. (75-mm) sieve
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay
[E] $Cu = D_{60}/D_{10}$ Cc =
[F] If soil contains $\geq$ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains $\geq$ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L] If soil contains $\geq$ 30% plus No. 200 predominantly sand, add "sandy" to group name.
[M] If soil contains $\geq$ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] $PI \geq 4$ and plots on or above "A" line.
[O] $PI < 4$ or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.