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June 16, 2017

Mr. Craig Pazarena
1159 Rolling Pines Drive
Ortonville, MI 48462

Geotechnical Engineering Evaluation
Pazarena Residence Additions
8430 SE 47th Place
Mercer Island, Washington
NGA File No. 996317

Dear Mr. Pazarena:

We are pleased to submit the attached report titled "Geotechnical Engineering Evaluation – Pazarena Residence Additions – 8430 SE 47th Place – Mercer Island, Washington." The tax parcel for this property is 3317500120. Although we completed work on the site in 2003, this updated report summarizes the existing surface and subsurface conditions within the site and provides recommendations for the newly proposed site development. Our services were completed in general accordance with the proposal signed by you on May 24, 2017.

The ground surface within the center of the property is bowl-shaped, with gentle slopes overall trending to the west. Moderate to steep, northwesterly facing slopes border the property along the northwestern perimeter, leading down to a small creek on the adjacent property. The southern portion of the property includes a 10-foot wide sewer easement. In total, the property extends approximately 150 feet in the north-south direction, and between 45 and 80 feet in the east-west direction. The property is bordered to the north by Southeast 47th Place, and on all other sides by single-family residences.

The proposed development portions of the site are located in the northwestern and central portions of the property. They include additions to the existing detached garage, including the addition of a second story, as well as a separate detached 'pool house' addition elsewhere on the property. Final grading plans have not been developed; however, we anticipate that retaining walls will likely be needed for the planned grading. Final stormwater plans have not been developed at the time this report was written.

We recently explored the site with five hand auger boreholes to supplement previous explorations on the site which included two test pits, and mapped the conditions on the site slopes. Our explorations indicated that the site is underlain by competent native glacial soils. The site slopes appear to be generally stable with respect to deep-seated landsliding, and it is our opinion that the planned development is feasible from a geotechnical standpoint, provided that our recommendations are incorporated into the design and construction of this project. We have recommended that the new structures be founded on the medium dense or better native soil for bearing capacity and settlement considerations. These soils should generally be encountered approximately three to five feet below the existing ground surface, based on our explorations. However, deeper areas of loose soil and/or undocumented fill could also exist within unexplored areas of the site. General recommendations for retaining walls, as well as recommendations for site grading, subgrade preparation, drainage, and erosion control are further discussed in the attached report.

We recommend that we be retained to provide a review of the building placement and site drainage plans after they have been developed to verify that our recommendations have been incorporated into project plans. We also recommend that NGA be retained to provide monitoring and consultation services during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork and foundation installation activities comply with contract plans and specifications.

We appreciate the opportunity to provide service to you on this project. Please contact us if you have any questions regarding this report or require further information.

Sincerely,

NELSON GEOTECHNICAL ASSOCIATES, INC.

Khaled M. Shawish, PE
Principal

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Geotechnical Engineering Evaluation
Pazarena Residence Additions
8430 SE 47th Place
Mercer Island, Washington

INTRODUCTION

This report presents the results of our preliminary geotechnical engineering investigation and evaluation of the Pazarena residence additions on Mercer Island, Washington. The project site is located 8430 SE 47th Place, as shown on the Vicinity Map in Figure 1. The Tax Parcel number for the property is listed as 3317500120. Although we completed work on the site in 2003, this updated report summarizes the existing surface and subsurface conditions within the site and provides recommendations for the newly proposed site development. For our use in preparing this report, we have been provided with a site plan titled “Pazarena DADU – SD Site Plan, SK-01”, prepared by Neiman Taber, dated May 17, 2017.

The planned improvements will include expansions to the existing detached garage, including the addition of a second story and pool room, as well as a separate detached ‘pool house’ addition elsewhere on the property. The ground surface within the center of the property is bowl-shaped, with gentle slopes overall trending to the west. Moderate to steep, northwesterly facing slopes border the property along the northwestern perimeter, leading down to a small creek on the adjacent property. The site is currently occupied by a single-family residence and detached garage, and is moderately vegetated with underbrush and mature trees. Final grading plans were not developed at the time this report was prepared; however, we anticipate that site grading will consist of cuts and fills for the residence building pads and driveway construction. Final stormwater plans have not been developed at the time this report was prepared. The existing site conditions and proposed development area are shown on the Site Plan in Figure 2.

SCOPE

The purpose of this study is to explore and characterize the site surface and subsurface conditions, and provide general recommendations for site development. Specifically, our scope of services included the following:

1. A review of available soil and geologic maps of the area.
2. A review of plans for new foundation elements, as provided.
3. Exploring the subsurface soil and groundwater conditions within the vicinity of the existing and planned residence using hand auger explorations.
4. Providing recommendations regarding suitability of the existing foundation for support of the renovated structure.
5. Providing recommendations for foundation support for new footings.

6. Providing recommendations for pavement and slab-on-grade support.
7. Providing recommendations for site drainage and erosion control.
8. Documenting the results of our findings, conclusions, and recommendations in a written geotechnical report.

SITE CONDITIONS

Surface Conditions

The site consists of an irregular-shaped property covering approximately 0.31 acres. The property extends approximately 150 feet in the north-south direction, and between 45 and 80 feet in the east-west direction. The property is bordered to the north by Southeast 47th Place, and on all other sides by single-family residences. It includes a 10-foot wide sewer easement in the southern portion, and a 50-foot watercourse setback is located within the northwest corner. The proposed development portions of the site are located in the northwestern and central portions of the property. Approximately 10 feet away from the proposed garage addition, a northwesterly facing slope descends at 27 degrees (51 percent grade), terminating in a shallow, southwest trending ravine in the adjacent property. To the south of the existing garage, the central areas of the site are bowl-shaped, with gentle to moderate slopes overall trending to the west at gradients in the range of approximately 5 to 16 degrees (9 to 29 percent), although a short, steep, southwesterly facing slope to the south of the existing garage was measured at a gradient of 30 degrees (58 percent). The pool room addition is proposed to extend 14 feet to the south of the existing garage, which would place portions of the foundation on the steep slope. The slope inclinations within the site are shown on Cross-Sections A-A', B-B', and C-C' in Figures 3 through 5, respectively.

The site is generally covered with young to mature trees and dense underbrush. We did not observe significant signs of surficial slope movement on the site slopes. We observed flowing surface water in the adjacent property near the northwest perimeter, which was flowing southwest from a concrete culvert beneath the road.

Subsurface Conditions

Geology: The geologic units for this area are shown on the Geologic Map of Mercer Island, Washington, by Kathy G. Troost and Aaron P. Wisher (City of Mercer Island, ESS, University of Washington, 2006). The site is mapped Qvt (glacial till) with Qvlc (Lawton Clay) mapped nearby. The glacial till is described as a nonsorted mixture of clay, silt, sand, pebbles, cobbles, and boulders, while Lawton Clay is described as massive silt, clayey silt, and silty clay deposited in lakes dammed by the continental glacier during the Vashon Stade. The soils generally encountered in our explorations consisted of silty fine to medium sand with gravel and fine to medium sand with gravel soils consistent with the description of native glacial till and advance outwash deposits, which are composed of sandy material, and were deposited in front of the advancing glacier.

Explorations: The subsurface conditions within the site were explored on May 8, 2003 by excavating two test pits to depths of 6.3 and 6.8 feet below the existing ground surface and on May 31, 2017 by excavating five hand auger holes to depths between 3.2 to 9.2 feet below the existing surface. The approximate locations of our explorations are shown on the Site Plan in Figure 2. A geologist or engineer from NGA was present during the explorations, examined the soils and geologic conditions encountered, obtained samples of the different soil types, and maintained logs of the explorations.

The soils were visually classified in general accordance with the Unified Soil Classification System, presented in Figure 5. The logs of our explorations are attached to this report and are presented as Figures 7 through 9. We present a brief summary of the subsurface conditions in the following paragraph. For a detailed description of the subsurface conditions, the logs should be reviewed.

In all of our hand auger explorations, we encountered between 1.1 to 4.0 feet of surficial topsoil or undocumented fill composed of silty fine to medium sand and gravel with varying amounts of roots. Below the surficial soils in all of our explorations, we encountered brown to gray-brown, silty, fine to medium sand with fine gravel in an increasingly medium dense condition, which we interpreted as the native glacial till deposit. All hand auger boreholes were completed or were terminated within this unit at depths between 3.2 and 9.2 feet below the ground surface.

Test Pits 1 and 2, which were explored on May 8, 2003, encountered similar surficial soils between 1.7 and 3.3 feet below the surface, which we interpreted as undocumented fill or topsoil. These loose soils were underlain by 0.9 to 4.1 feet of gray-brown silty fine to medium sand with gravel in an increasingly medium dense condition, which we interpreted as native glacial till. Underlying the till, Test Pit 1 encountered wet, medium to coarse sand with silt, which was interpreted to be advance outwash at a depth of 5.8 feet. This material extended to the depth explored, 6.8 feet. Test Pit 2 encountered moist, gray-brown medium sand with silt, becoming silt with fine to medium sand and gravel at a depth of 5.8 feet. This unit extended to the depth explored, 6.3 feet.

Hydrologic Conditions

Groundwater seepage was encountered in all of our explorations, except Hand Auger 1 and Test Pit 2. Groundwater seepage was encountered between 3.1 feet (Hand Auger 5) and 8.7 feet (Hand Auger 2), although when observed, it was generally found around 4.0 feet. Since shallow groundwater seepage occurs on this site, we would interpret the water to be perched water. Perched water occurs when surface water infiltrates through less dense, more permeable soils and accumulates on top of relatively low permeability materials. The more permeable soils consist of the topsoil/weathered soils. The low permeability soil consists of relatively silty glacial soils. Perched water does not represent a regional groundwater "table" within the upper soil horizons. Perched water tends to vary spatially and is dependent upon the amount of rainfall. We would expect the amount of perched groundwater to decrease during drier times of the year and increase during wetter periods.

We did not observe groundwater seepage emitting on the site slopes, but did observe the stream flowing through the shallow ravine adjacent to the northwestern portion of the property. It appears that water likely flows within the ravine throughout most of the year, although it may be linked to stormwater runoff fluctuations.

SENSITIVE AREA EVALUATION

Seismic Hazard

The 2015 International Building Code (IBC) seismic design section provides a basis for seismic design of structures. Table 1 below provides seismic design parameters for the site that are in conformance with the 2015 IBC, which specifies a design earthquake having a 2% probability of occurrence in 50 years (return interval of 2,475 years), and the 2008 USGS seismic hazard maps.

Table 1 – 2015 IBC Seismic Design Parameters

Site Class	Spectral Acceleration at 0.2 sec. (g) S_s	Spectral Acceleration at 1.0 sec. (g) S_1	Site Coefficients		Design Spectral Response Parameters	
			F_a	F_v	S_{DS}	S_{D1}
D	1.440	0.500	1.000	1.800	0.960	0.600

The spectral response accelerations were obtained from the USGS Earthquake Hazards Program Interpolated Probabilistic Ground Motion website (2008 data) for the project latitude and longitude.

Hazards associated with seismic activity include liquefaction potential and amplification of ground motion by soft deposits. Liquefaction is caused by a rise in pore pressures in a loose, fine sand deposit beneath the groundwater table. The glacial soils interpreted to underlie the site have a low potential for liquefaction or amplification of ground motion.

Although mass wasting deposits and landslide scarps are mapped in the vicinity of the site, the glacial soils interpreted to form the core of the site slopes are considered stable with respect to deep-seated slope failures within the site. However, the overlying loose surficial materials on the slopes have the potential for shallow sloughing failures during seismic events. Such events should not affect the planned residence structures provided the foundations are designed with the recommended setback and embedment values as described in this report.

Erosion Hazard

The criteria used for determination of erosion hazard areas include soil type, slope gradient, vegetation cover, and groundwater conditions. The erosion sensitivity is related to vegetative cover and the specific surface soil types, which are related to the underlying geologic soil units. The Soil Survey of King County Area, Washington, by the Soil Conservation Service (SCS) lists the soils within the site as Kitsap silt loam, 15 to 30 percent slopes (KpD). These soils are derived from lake bottom deposits and include a minor component of volcanic ash, forming relatively flat terraces. Soils on this site to have a moderate to severe erosion hazard where the vegetative cover is removed. The on-site soils should have a low to moderate hazard for erosion where the vegetation is not disturbed.

Landslide Hazard/Slope Stability

The criteria used for evaluation of landslide hazards include soil type, slope gradient, and groundwater conditions. The proposed development portions of the site are located in the northwestern and central portions of the property. Approximately 10 feet away from the proposed development adjacent to the garage, a northwesterly facing slope descends at gradients in the range of approximately 10 to 27 degrees (18 to 51 percent grade), terminating in a shallow, southwest trending ravine in the adjacent property. To the south of the garage, the central areas of the site are bowl-shaped, with gentle to steep slopes overall trending to the west at gradients in the range of approximately 5 to 16 degrees, although a short southwesterly facing slope to the south of the garage was measured at a gradient of 30 degrees (9 to 29, and 58 percent respectively).

We did not observe evidence of significant slope instability within the property during our investigation, such as deep-seated landsliding, although the areas within the vicinity and including the site have been identified as a mass-wasting zone, surrounded by scarps which appear to be diffused when viewed under LiDAR imagery, suggesting landslide activity is relatively old, although no specific age-dating information has been completed within this mass wasting zone. We also did not observe significant groundwater seepage from- or signs of erosion or sloughing on the slopes at the time of our visit. However, we did observe minor amounts of water flowing through the neighboring ravine during our site visit, and shallow groundwater conditions, which have also been mapped as part of the landslide hazard area by Mercer Island.

The core of the site slopes is inferred to consist primarily of medium dense or better native glacial soils. Inclinations of up to 30 degrees (58 percent) on the slopes within the property indicate high internal strength within the underlying soils. Relatively shallow sloughing failures as well as surficial erosion are natural processes and should be expected on these slopes during extreme weather conditions. It is our opinion that while there is potential for erosion, soil creep, and shallow failures within the loose surficial soils on the steep slopes, there is not a significant potential for deep-seated slope failure under current site conditions.

Proper site grading and drainage as well as adequate setback distances and foundation placement as recommended in this report should help maintain current stability conditions.

CONCLUSIONS AND RECOMMENDATIONS

General

It is our opinion that the planned development is feasible from a geotechnical standpoint. It is also our opinion that the soils that underlie the site and form the core of the site slopes should be stable with respect to deep-seated earth movements, due to their inherent strength and slope geometry. There is, however, a potential for shallow sloughing and erosion events to occur on the steeper portions of the slopes, especially in the upper loose surficial soils, including the undocumented fill slopes to the south of the existing garage. Proper erosion and drainage control measures should reduce this potential. We recommend that we be retained to review the plans after they have been developed.

A 50-foot watercourse buffer is shown on the provided site plan. We understand that you wish to reduce the buffer to a distance of 25 feet in order to build the garage addition. The watercourse buffer is environmental in nature, and is outside of our area of expertise as geotechnical consultants. As such, efforts to reduce the buffer should be completed with the City of Mercer Island and environmental consultants.

Our explorations indicated that the site is underlain by competent native glacial soils at depth. These glacial soils should provide adequate support for foundation, slab, and pavement loads. We recommend that the structures be designed utilizing shallow conventional foundations. Footings should extend through any loose surficial soil and undocumented fill, and be keyed into the underlying competent native soils. These soils should be encountered roughly two to three feet below the existing ground surface. We recommend that the downhill foundation lines be embedded a minimum of six feet into the competent native soils to provide an effective setback of 20 feet from the toe of the slope to the base of the foundation. We should be retained to evaluate the addition foundation setback distances and subgrade soil prior to placing foundation forms. Alternatively, if shallow conventional foundations with the above recommendations are not feasible, drilled pier foundations should be pursued. We are able to provide design recommendations for this alternative foundation upon request.

The location of the ‘pool house’ addition has not been determined at the time this report was prepared. A building setback of at least 15 feet and a 25-foot wide buffer from the steep northwesterly-facing ravine slopes and south-facing slopes to the west and south of the proposed development areas should be utilized for the ‘pool house’ addition, provided the downhill foundation lines are embedded a minimum of two feet into the competent native soils. We should be retained to evaluate the addition foundation setback distances and subgrade soil prior to placing foundation forms for this additional structure as well.

All grading operations and drainage improvements planned as part of this development should be planned and completed in a matter which enhances the stability of the steep slopes, not reduces it. Excavation spoils should not be stockpiled near the slopes or be allowed to encroach on the slopes. Also, runoff generated within the site should be collected and routed into a permanent discharge system and not be allowed to flow over the slopes. Future vegetation management on the slope should be the subject of a specific evaluation and a plan approved by the City of Mercer Island. The slopes should be monitored on an on-going basis, especially during the wet season, for any signs of instability, and corrective actions promptly taken should any signs of instability be observed. Lawn clipping and any other household trash or debris should never be allowed to reach the slopes.

The surficial soils encountered on this site are considered moisture-sensitive and will disturb easily when wet. To lessen the potential impacts of construction on the slopes and to reduce cost overruns and delays, we recommend that construction take place during the drier summer months. If construction takes place during the rainy months, additional expenses and delays should be expected. Additional expenses could include the need for placing erosion control and temporary drainage measures to protect the slopes, the need for placing a blanket of rock spalls on exposed subgrades, and construction traffic areas prior to placing structural fill, and the need for importing all-weather material for structural fill.

Under no circumstances, should water be allowed to flow over or concentrate on the site slopes, both during construction, and after construction has been completed. We recommend that stormwater runoff from the roof and yard drains be collected and tightlined to a suitable discharge point. The slopes should be protected from erosion. We recommend that all disturbed areas be replanted with vegetation to re-establish vegetation cover as soon as possible. Specific recommendations for erosion control are presented in the **Erosion Control and Slope Protection Measures** subsection of this report.

Erosion Control and Slope Protection Measures

The erosion hazard for the on-site soils is considered to be moderate, but the actual hazard will be dependent on how the site is graded and how water is allowed to concentrate. Best Management Practices (BMPs) should be used to control erosion. Areas disturbed during construction should be protected from erosion. Erosion control measures may include diverting surface water away from the stripped or disturbed areas. Silt fences and/or straw bales should be erected to prevent muddy water from leaving the site or flowing over the slopes. Stockpiles should be covered with plastic sheeting during wet weather and stockpiled material should be no closer than 25 feet from the top of the slopes. Disturbed areas should be planted as soon as practical and the vegetation should be maintained until it is established. The erosion potential for areas not stripped of vegetation should be low.

Protection of the setback and steep slope areas should be performed as required by the City of Mercer Island. Specifically, we recommend that the sloping areas outside the proposed development area not be disturbed or modified through placement of any fill or removal of the existing vegetation. No additional material of any kind should be placed on either slope or be allowed to reach the slopes, such as excavation spoils, lawn clippings, and other yard waste, trash, and soil stockpiles. Trees should not be cut down or removed from the slopes unless a mitigation plan is developed, such as the replacement of vegetation for erosion protection. Vegetation should not be removed from the slopes. Replacement of vegetation should be performed in accordance with the City of Mercer Island code. Any proposed development within the slope setback area, other than light decks or patios, should be the subject of a specific geotechnical evaluation. Under no circumstances should water be allowed to concentrate on the slopes.

Site Preparation and Grading

After erosion control measures are implemented, site preparation should consist of stripping any loose soils to expose medium dense or better native soil in foundation, slab-on-grade, and pavement areas. The stripped materials should be removed from the site. Stockpiles should be kept a minimum of 25 feet away from the top of the steep slopes and should be covered with plastic.

If the ground surface, after site stripping, should appear to be loose, it should be compacted to a non-yielding condition. Areas observed to pump or weave during compaction should be over-excavated and replaced with properly compacted structural fill or rock spalls. If loose soils are encountered in any slab areas, the loose soils should be removed and replaced with rock spalls or granular structural fill. If significant surface water flow is encountered during construction, this flow should be diverted around areas to be developed, and the exposed subgrades should be maintained in a semi-dry condition.

This site is underlain by moisture sensitive soils. Due to these conditions, special site stripping and grading techniques might be necessary. These could include using large excavators equipped with wide tracks and a smooth bucket to complete site grading and promptly covering exposed subgrades with a layer of crushed rock for protection. If wet conditions are encountered or construction is attempted in wet weather, the subgrade should not be compacted as this could cause further subgrade disturbance. In wet conditions, it may be necessary to cover the exposed subgrade with a layer of crushed rock as soon as it is exposed to protect the moisture sensitive soils from disturbance by machine or foot traffic during construction. The prepared subgrade should be protected from construction traffic and surface water should be diverted around prepared subgrade. Shallow groundwater, if encountered, should be intercepted with cut-off drains and routed around the planned grading area, or the groundwater should be controlled with sump-pumps or dewatering systems. Failure to follow these recommendations could cause erosion and failures on the slopes, as well as result in inadequate subgrades.

Structure Setbacks

Uncertainties related to building along steep slopes are typically addressed by the use of building setbacks. The purpose of the setback is to establish a "buffer zone" between the structure and the top of the slope so that ample room is allowed for normal slope recession during a reasonable life span of the structure. In a general sense, the greater the setback distance, the lower the risk of slope failures impacting the structures. From a geological standpoint, the setback dimension is based on the slope's physical characteristics, such as slope height, surface angle, material composition, and hydrology. Other factors such as historical slope activity, rate of regression, and the type and desired life span of the development are important considerations as well.

Grading plans and the separate 'pool house' addition structure location have not been determined at the time this report was prepared. A building setback of at least 15 feet and a 25-foot wide buffer from the steep northwesterly-facing ravine slopes and south-facing slopes to the west and south of the proposed development areas should be utilized for the 'pool house' addition, provided the downhill foundation lines are embedded a minimum of two feet into the competent native soils. Development of all structures should adhere to adjustments to buffer and/or setback requirements related to the watercourse as determined by the City of Mercer Island or licensed environmental consultants.

We should be retained to evaluate the residence foundation setback distances and subgrade soil prior to placing foundation forms. Any proposed development within the setback area, other than light decks or patios, should be the subject of a specific geotechnical evaluation. Under no circumstances should any water generated on the site be allowed to concentrate on the slopes, during or after construction.

Temporary and Permanent Slopes

Temporary cut slope stability is a function of many factors, including the type and consistency of soils, depth of the cut, surcharge loads adjacent to the excavation, length of time a cut remains open, and the presence of surface water or groundwater. It is exceedingly difficult under these variable conditions to estimate a stable, temporary, cut slope angle. Therefore, it should be the responsibility of the contractor to maintain safe slope configurations since they are continuously at the job site, able to observe the soil and groundwater conditions encountered, and able to monitor the nature and condition of the cut slopes.

The following information is provided solely for the benefit of the owner and other design consultants and should not be construed to imply that Nelson Geotechnical Associates, Inc. assumes responsibility for job site safety. Job site safety is the sole responsibility of the project contractor.

For planning purposes, we recommend that temporary cuts in the on-site soils be no steeper than 1.5H:1V. If significant groundwater seepage or surface water flow were encountered, we would expect that flatter inclinations would be necessary. We recommend that cut slopes be protected from erosion. The slope protection measures may include covering cut slopes with plastic sheeting and diverting surface runoff away from the top of cut slopes. We do not recommend vertical slopes for cuts deeper than four feet, if worker access is necessary. We recommend that cut slope heights and inclinations conform to appropriate OSHA/WISHA regulations. If the above inclinations cannot be met due to property line constraints and/or worker access issues, we recommend that shoring be considered for the planned cuts. We are available to provide specific recommendations for temporary shoring once grading plans have been finalized.

Permanent cut and fill slopes should be no steeper than 2H:1V, unless specifically approved by NGA. Also, flatter inclinations may be required in areas where loose soils are encountered. Permanent slopes should be vegetated and the vegetative cover maintained until established. We should specifically review all plans for grading on steep slopes for this project.

Foundation Support

Conventional shallow spread foundations should be placed on undisturbed medium dense or better native soils. Medium dense soils should be encountered roughly two to three feet below the ground surface based on our explorations; however, deeper loose soil may be encountered in unexplored areas of the site. Where undocumented fill or less dense soils are encountered at footing bearing elevation, the subgrade should be over-excavated to expose suitable bearing soil. In addition, we recommend that the downhill eastern and northern foundation lines be embedded a minimum of six feet into the competent native soils.

Footings should extend at least 18 inches below the lowest adjacent finished ground surface for frost protection and bearing capacity considerations. Foundations should be designed in accordance with the 2015 IBC. Footing widths should be based on the anticipated loads and allowable soil bearing pressure. Water should not be allowed to accumulate in footing trenches. All loose or disturbed soil should be removed from the foundation excavation prior to placing concrete.

For foundations constructed as outlined above, we recommend an allowable design bearing pressure of not more than 2,000 pounds per square foot (psf) be used for the footing design for footings founded on the medium dense or better native soils or structural fill extending to the native competent material. The foundation bearing soil should be evaluated by a representative of NGA. We should be consulted if higher bearing pressures are needed. Current IBC guidelines should be used when considering increased allowable bearing pressure for short-term transitory wind or seismic loads. Potential foundation settlement using the recommended allowable bearing pressure is estimated to be less than one inch total and 1/2 inch differential between adjacent footings or across a distance of about 20 feet, based on our experience with similar projects.

Lateral loads may be resisted by friction on the base of the footing and passive resistance against the subsurface portions of the foundation. A coefficient of friction of 0.35 may be used to calculate the base friction and should be applied to the vertical dead load only. Passive resistance may be calculated as a triangular equivalent fluid pressure distribution. An equivalent fluid density of 200 pounds per cubic foot (pcf) should be used for passive resistance design for a level ground surface adjacent to the footing. This level surface should extend a distance equal to at least three times the footing depth. These recommended values incorporate safety factors of 1.5 and 2.0 applied to the estimated ultimate values for frictional and passive resistance, respectively. To achieve this value of passive resistance, the foundations should be poured "neat" against the native medium dense soils or compacted fill should be used as backfill against the front of the footing. We recommend that the upper one-foot of soil be neglected when calculating the passive resistance.

Retaining Walls

Retaining walls may be needed for the residence, driveway, and other areas of the site. All walls over four feet in height, tiered walls, or walls planned near or on slopes would need to be specifically designed and reviewed by NGA.

In general, the lateral pressure acting on subsurface retaining walls is dependent on the nature and density of the soil behind the wall, the amount of lateral wall movement which can occur as backfill is placed, wall drainage conditions, and the inclination of the backfill. For walls that are free to yield at the top at least one thousandth of the height of the wall (active condition), soil pressures will be less than if movement is limited by such factors as wall stiffness or bracing (at-rest condition). We recommend that walls supporting horizontal backfill and not subjected to hydrostatic forces, be designed using a triangular earth pressure distribution equivalent to that exerted by a fluid with a density of 40 pcf for yielding (active condition) walls, and 60 pcf for non-yielding (at-rest condition) walls.

These recommended lateral earth pressures are for a drained granular backfill and are based on the assumption of a horizontal ground surface behind the wall for a distance of at least the subsurface height of the wall, and do not account for surcharge loads. Additional lateral earth pressures should be considered for surcharge loads acting adjacent to subsurface walls and within a distance equal to the subsurface height of the wall. This would include the effects of surcharges such as traffic loads, floor slab loads, slopes, or other surface loads. We could consult with the structural engineer regarding additional loads on retaining walls during final design, if needed.

The lateral pressures on walls may be resisted by friction between the foundation and subgrade soil, and by passive resistance acting on the below-grade portion of the foundation. Recommendations for frictional and passive resistance to lateral loads are presented in the **Foundations** subsection of this report.

All wall backfill should be well compacted as outlined in the **Structural Fill** subsection of this report. Care should be taken to prevent the buildup of excess lateral soil pressures, due to over-compaction of the wall backfill. This can be accomplished by placing wall backfill in eight-inch loose lifts and compacting the backfill with small, hand-operated compactors within a distance behind the wall equal to at least one-half the height of the wall. The thickness of the loose lifts should be reduced to accommodate the lower compactive energy of the hand-operated equipment. The recommended level of compaction should still be maintained.

Permanent drainage systems should be installed for retaining walls. Recommendations for these systems are found in the **Subsurface Drainage** subsection of this report. We recommend that we be retained to evaluate the proposed wall drain backfill material and observe installation of the drainage systems.

Structural Fill

General: Fill placed beneath foundations, slabs, pavements, or other settlement-sensitive structures should be placed as structural fill. Structural fill, by definition, is placed in accordance with prescribed methods and standards, and is monitored by an experienced geotechnical professional or soils technician. Field monitoring procedures would include the performance of a representative number of in-place density tests to document the attainment of the desired degree of relative compaction. The area to receive the fill should be suitably prepared as described in the **Site Preparation and Grading** subsection prior to beginning fill placement. Sloping areas to receive fill should be benched to key the fill into the sloping grade. The benches should be level and a minimum of six feet wide.

Materials: Structural fill should consist of a good quality, granular soil, free of organics and other deleterious material, and be well graded to a maximum size of about three inches. All-weather structural fill should contain no more than five-percent fines (soil finer than U.S. No. 200 sieve, based on that fraction passing the U.S. 3/4-inch sieve). Some of the on-site soils may be used as structural fill; however, this will highly depend on the material’s moisture contents at the time of construction. The use of the on-site soil as structural fill during wet weather will be nearly impossible. We should be retained to evaluate proposed structural fill material prior to placement.

Fill Placement: Following subgrade preparation, placement of structural fill may proceed. All filling should be accomplished in uniform lifts up to eight inches thick. Each lift should be spread evenly and be thoroughly compacted prior to placement of subsequent lifts. All structural fill should be compacted to a minimum of 95 percent of its maximum dry density. Maximum dry density, in this report, refers to that density as determined by the ASTM D-1557 Compaction Test procedure. The moisture content of the soils to be compacted should be within about two percent of optimum so that a readily compactable condition exists. It may be necessary to over-excavate and remove wet soils in cases where drying to a compactable condition is not feasible. All compaction should be accomplished by equipment of a type and size sufficient to attain the desired degree of compaction.

Slab-on-Grade

Slabs-on-grade should be supported on subgrade soils prepared as described in the **Site Preparation and Grading** subsection of this report. We recommend that all floor slabs be underlain by at least six inches of free-draining gravel with less than three percent by weight of the material passing Sieve #200 for use as a capillary break. We recommend that the capillary break be hydraulically connected to the footing drain system to allow free drainage from under the slab. A suitable vapor barrier, such as heavy plastic sheeting (6-mil minimum), should be placed over the capillary break material. An additional 2-inch thick moist sand layer may be used to cover the vapor barrier. This sand layer is optional and is intended to protect the vapor barrier membrane during construction.

Site Drainage

Surface Drainage: Final site grades should allow for drainage away from the top of the slopes and away from the planned residence structures. We suggest that the finished ground be sloped at a minimum gradient of three percent for a distance of at least 10 feet away from the buildings and top of the slopes. Runoff generated on this site should be collected and routed into a permanent discharge system at the bottom of the slope. This should include all downspouts and runoff generated on all hard surfaces and yards areas. Under no circumstances should water be allowed to flow uncontrolled over the slopes. Water should not be allowed to collect in any area where footings or slabs are to be constructed. Under no circumstances should any water generated on this site be allowed to flow uncontrollably over the site slopes either during construction or on a permanent basis after the improvements are complete.

Subsurface Drainage: If groundwater is encountered during construction, we recommend that the contractor slope the bottom of the excavation and collect the water into ditches and small sump pits where the water can be pumped out of the excavation and routed into a suitable outlet. We recommend that the residence down spouts and footing drains be tightlined to an appropriate discharge location at the bottom of the steep slopes or into the drainage system on the road.

We recommend the use of footing drains around structures. Footing drains should be installed at least one foot below planned finished floor elevation. The drains should consist of a minimum four-inch-diameter, rigid, slotted or perforated, PVC pipe surrounded by free-draining material wrapped in a filter fabric. We recommend that the free-draining material consist of an 18-inch-wide zone of clean (less than three-percent fines), granular material placed along the back of walls. Washed rock is an acceptable drain material, or a drainage composite may be used instead. The free-draining material should extend up the wall to one foot below the finished surface. The top foot of soil should consist of low permeability soil placed over plastic sheeting or building paper to minimize the migration of surface water or silt into the footing drain. Footing drains should discharge into tightlines leading to an appropriate collection and discharge point with convenient cleanouts to prolong the useful life of the drains. Roof drains should not be connected to wall or footing drains.

USE OF THIS REPORT

NGA has prepared this report for Mr. Craig Pazarena and his agents, for use in the planning and design of the development planned on this site only. The scope of our work does not include services related to construction safety precautions and our recommendations are not intended to direct the contractors' methods, techniques, sequences, or procedures, except as specifically described in our report for consideration in design. There are possible variations in subsurface conditions between the explorations and also with time. Our report, conclusions, and interpretations should not be construed as a warranty of subsurface conditions. A contingency for unanticipated conditions should be included in the budget and schedule. This report is preliminary, and therefore, we recommend that we be retained to review the project plans after they have been developed to determine that recommendations in the report were incorporated into project plans.

All people who own or occupy homes with hills should realize that landslide movements are always a possibility. The landowner should periodically inspect the site slopes, especially after a winter storm. If distress is evident, a geotechnical engineer should be contacted for advice on remedial/preventative measures. The probability that landsliding will occur is substantially reduced by the proper maintenance of drainage control measures at the site (the runoff from the roofs should be led to an approved discharge point). Therefore, the homeowner should take responsibility for performing such maintenance. Consequently, we recommend that a copy of our report be provided to any future homeowners of the property if the home is sold.

We recommend that NGA be retained to provide monitoring and consultation services during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork and foundation installation activities comply with contract plans and specifications. We should be contacted a minimum of one week prior to construction activities and could attend pre-construction meetings if requested.

Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering practices in effect in this area at the time this report was prepared. No other warranty, expressed or implied, is made. Our observations, findings, and opinions are a means to identify and reduce the inherent risks to the owner.

It has been a pleasure to provide service to you on this project. If you have any questions or require further information, please call.

Sincerely,

NELSON GEOTECHNICAL ASSOCIATES, INC.

Carston Curd

Carston T. Curd, GIT
Staff Geologist

KHALED M. SHAWISH
STATE OF WASHINGTON
35215
REGISTERED
PROFESSIONAL ENGINEER

Exp. July 28, 2017

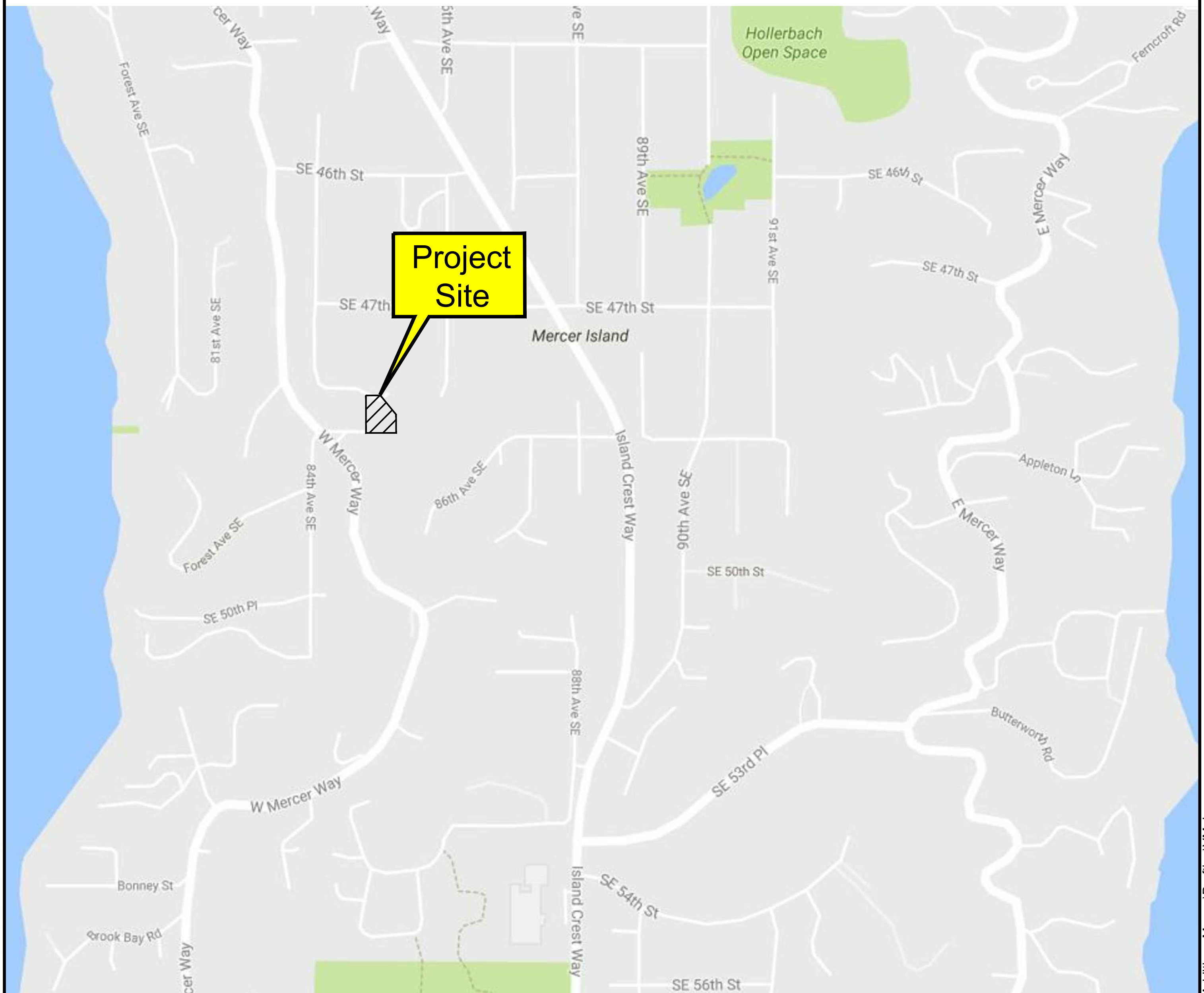
Khaled M. Shawish, PE
Principal

CTC:KMS:dy

Nine Figures Attached

VICINITY MAP

Not to Scale



Mercer Island, WA

Project Number 996317	Pazarena Residence Additions Vicinity Map	Nelson Geotechnical Associates, Inc.	No.	Date	Revision	By	CK
Figure 1		Geotechnical Engineers & Geologists	1	6/6/17	Original	DPN	CTC

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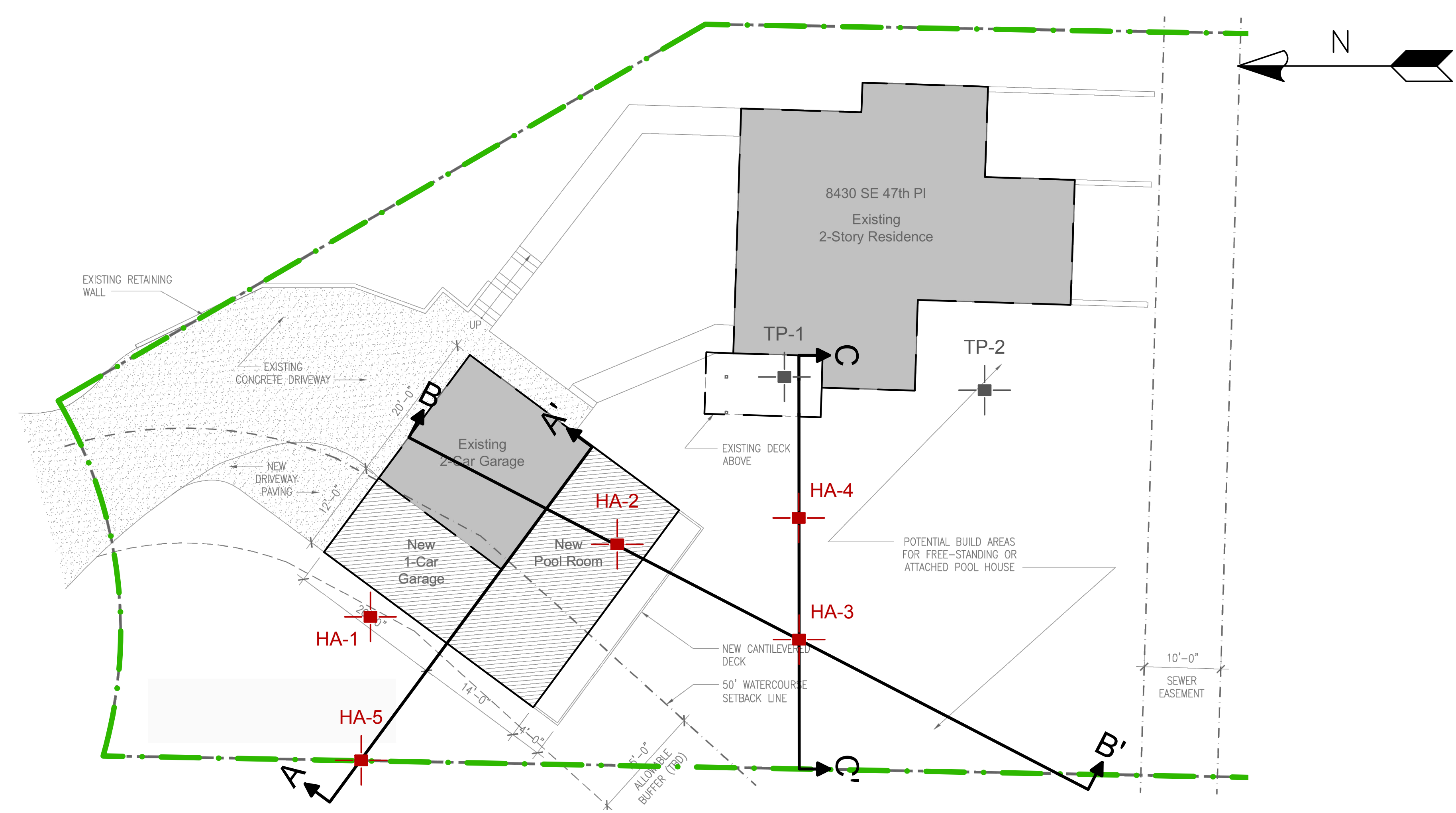

LEGEND

Property line

HA-1

Number and approximate location of hand auger performed on 5/31/17

TP-1

Number and approximate location of test pit performed on 5/8/03

A A'

Approximate location of cross-section

0 20 40

Scale: 1 inch = 20 feet

Reference: Site plan based on a plan dated May 17, 2017 titled "Pazarena DADU," prepared by Neiman Taber.

Project Number
996317

Figure 2

Pazarena Residence
Additions
Site Plan

NELSON GEOTECHNICAL ASSOCIATES, INC.
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No.	Date	Revision	By	CK
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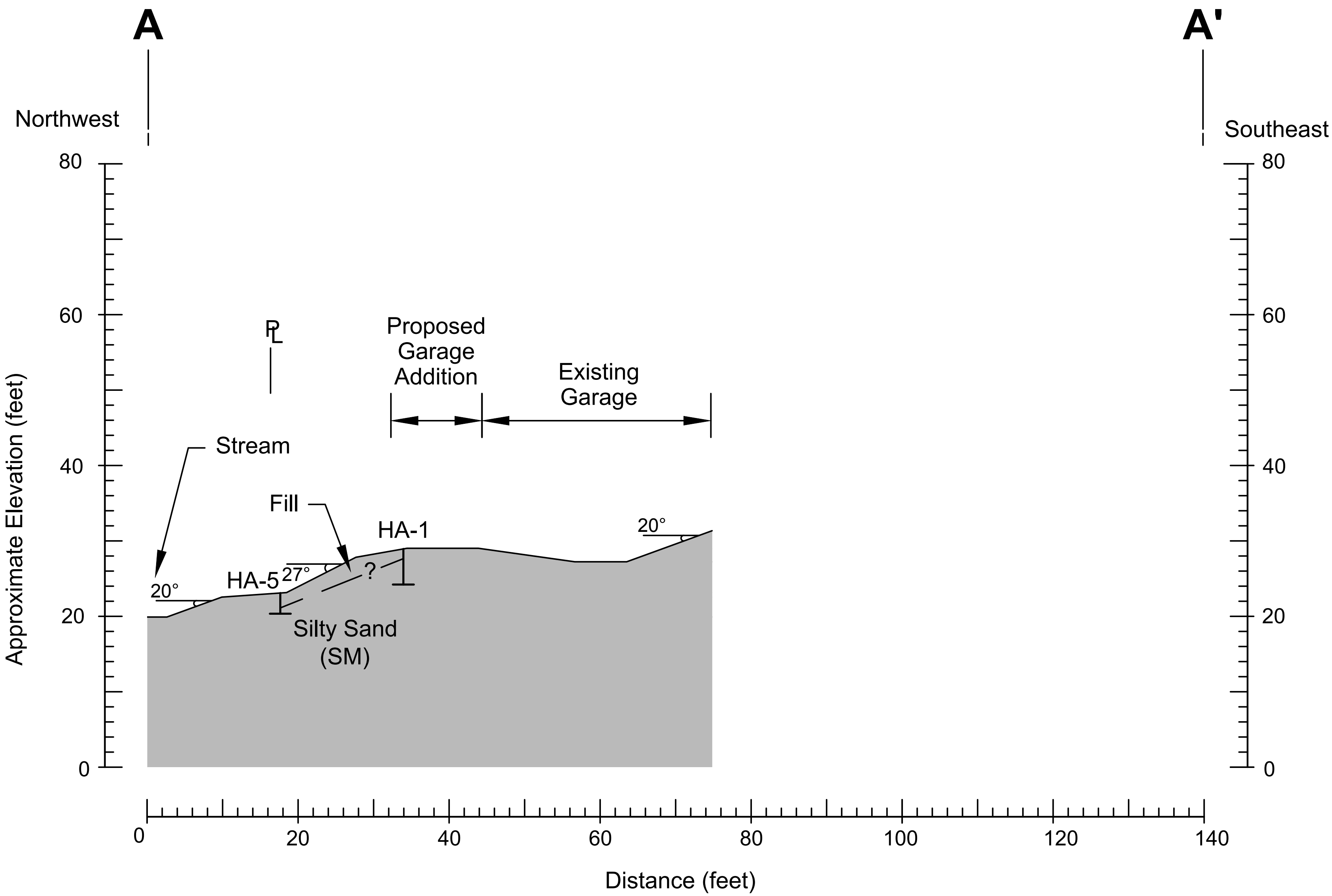

Exploration

Hand Auger Designation → HA-1

Groundwater Level During Exploration →

Geologic Contact (approximate) → ?— — —?

NOTES:
1) Stratigraphic conditions are interpolated between the explorations. Actual conditions may vary.
2) Elevations are approximate.

Reference: Cross Section is based on field measurements using a hand-held clinometer and 100-ft tape measure.

Project Number 996317

Figure 3

Pazarena Residence Additions
Cross-Section A-A'

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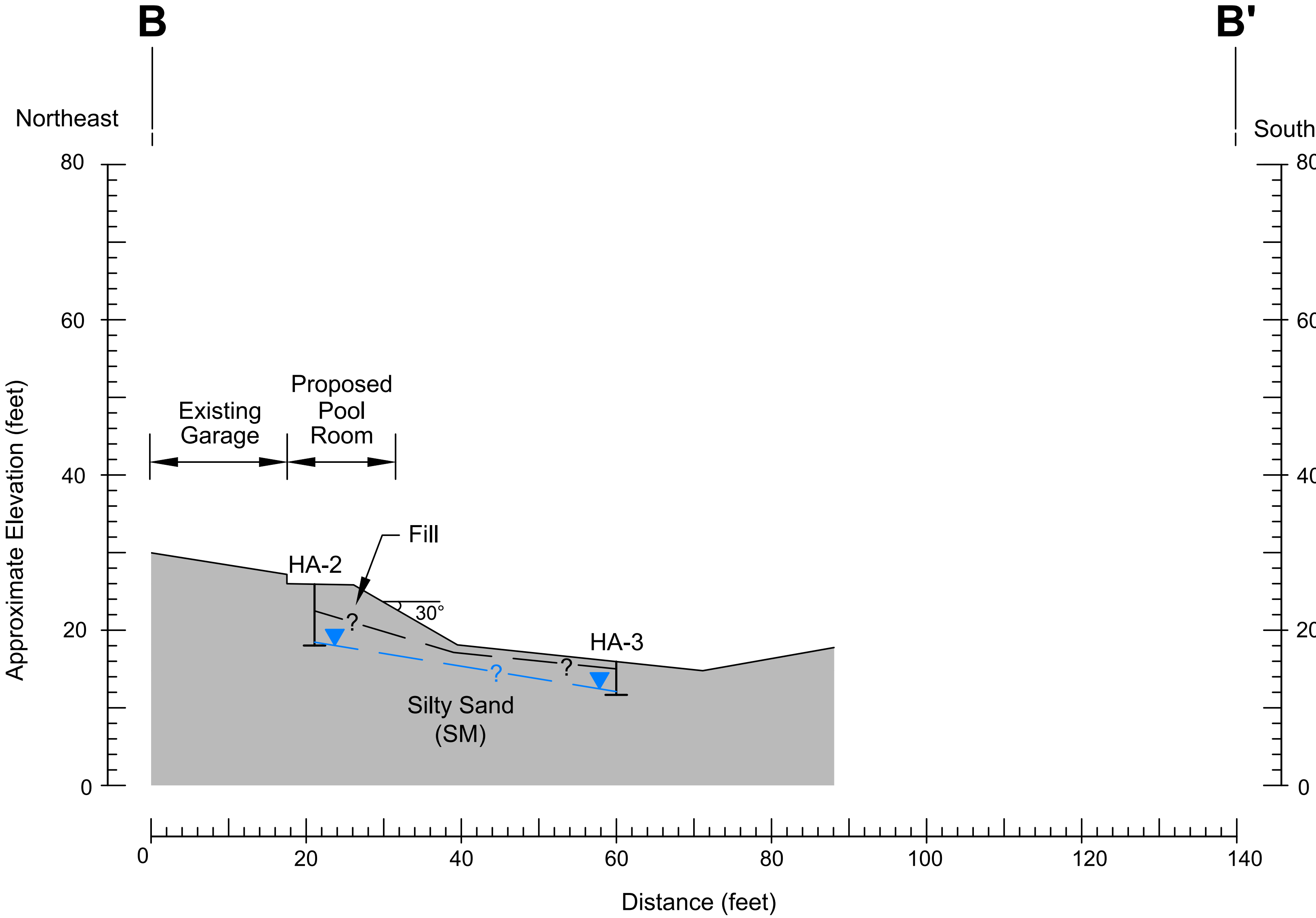
No.	Date	Revision	By	CK
1	6/6/17	Original	DPN	CTC



Exploration

Hand Auger Designation → HA-1

Groundwater Level During Exploration →

Geologic Contact (approximate) → ?— — —?

NOTES:
1) Stratigraphic conditions are interpolated between the explorations. Actual conditions may vary.
2) Elevations are approximate.

Reference: Cross Section is based on field measurements using a hand-held clinometer and 100-ft tape measure.

Project Number 996317

Figure 4

Pazarena Residence Additions

Cross-Section B-B'

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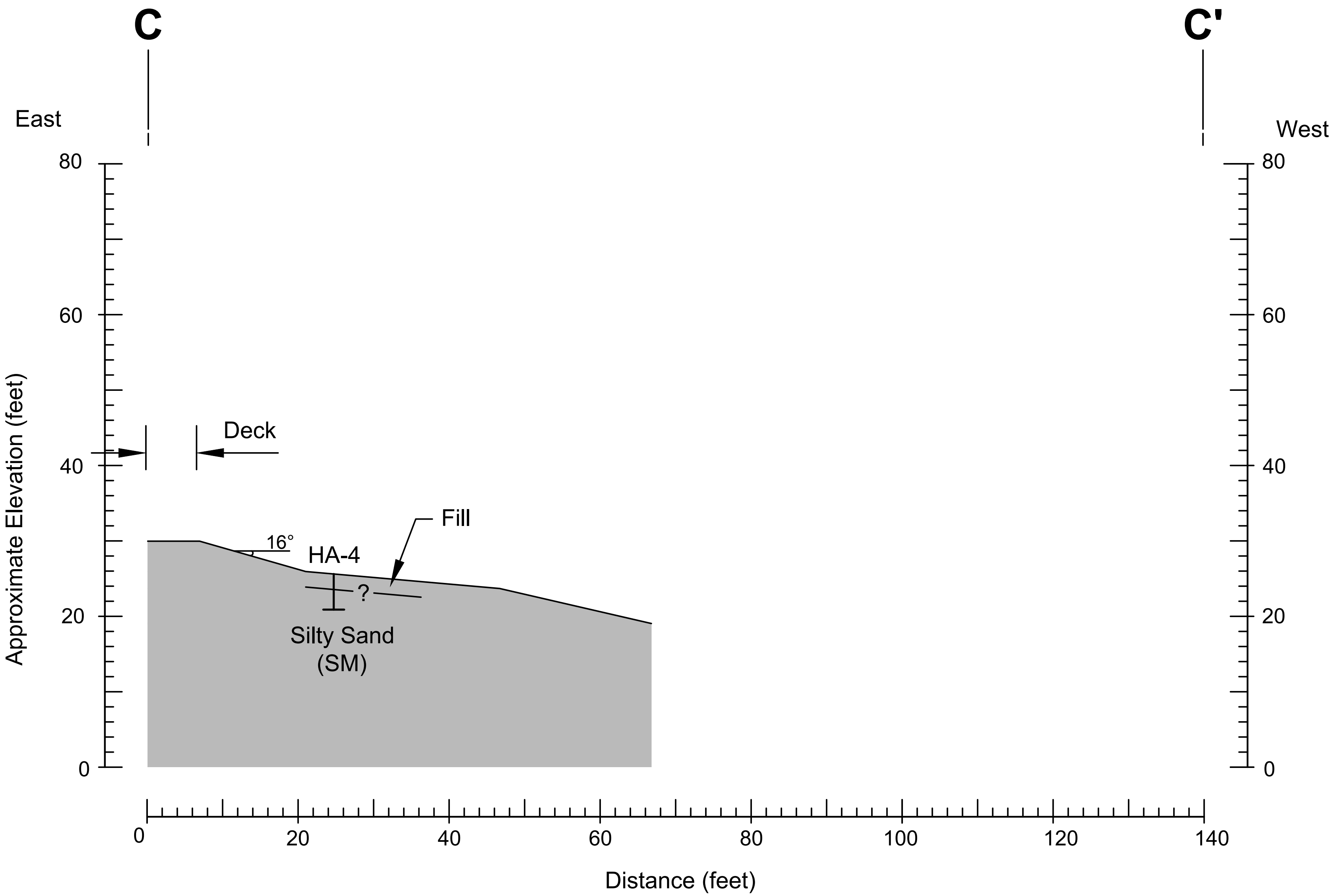
No.	Date	Revision	By	CK
1	6/6/17	Original	DPN	CTC



Exploration

Hand Auger Designation → HA-1

Groundwater Level During Exploration →

Geologic Contact (approximate) → ?— — —?

NOTES:
1) Stratigraphic conditions are interpolated between the explorations. Actual conditions may vary.
2) Elevations are approximate.

Reference: Cross Section is based on field measurements using a hand-held clinometer and 100-ft tape measure.

Project Number 996317

Figure 5

Pazarena Residence Additions
Cross-Section C-C'

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No.	Date	Revision	By	CK
1	6/6/17	Original	DPN	CTC

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE - GRAINED SOILS MORE THAN 50 % RETAINED ON NO. 200 SIEVE	GRAVEL MORE THAN 50 % OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVEL	GW	WELL-GRADED, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND MORE THAN 50 % OF COARSE FRACTION PASSES NO. 4 SIEVE	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE - GRAINED SOILS MORE THAN 50 % PASSES NO. 200 SIEVE	SILT AND CLAY LIQUID LIMIT LESS THAN 50 %	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY LIQUID LIMIT 50 % OR MORE	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FLAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1) Field classification is based on visual examination of soil in general accordance with ASTM D 2488-93.

2) Soil classification using laboratory tests is based on ASTM D 2488-93.

3) Descriptions of soil density or consistency are based on interpretation of blowcount data, visual appearance of soils, and/or test data.

SOIL MOISTURE MODIFIERS:

Dry - Absence of moisture, dusty, dry to the touch

Moist - Damp, but no visible water.

Wet - Visible free water or saturated, usually soil is obtained from below water table

Project Number 996317	Pazarena Residence Additions Soil Classification Chart	NELSON GEOTECHNICAL ASSOCIATES, INC.	No.	Date	Revision	By	CK
Figure 6		GEOTECHNICAL ENGINEERS & GEOLOGISTS	1	6/6/17	Original	DPN	CTC

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LOG OF EXPLORATION

DEPTH (FEET)	USC	SOIL DESCRIPTION
HAND AUGER ONE		
0.0 – 1.5		BROWN SILTY FINE TO MEDIUM SAND WITH FINE GRAVEL AND 1/2-INCH ROOTS (LOOSE, DRY-MOIST) (**FILL**)
1. 5 – 3.5	SM	GRAY-BROWN SILTY FINE TO MEDIUM SAND WITH FINE GRAVEL (LOOSE-MEDIUM DENSE, DRY-MOIST)
3.5 – 5.5	SM	GRAY-BROWN SILTY FINE TO MEDIUM SAND WITH FINE GRAVEL (MEDIUM DENSE, MOIST)
		SAMPLES WERE COLLECTED AT 3.5 AND 5.0 FEET GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED CAVING WAS NOT ENCOUNTERED HAND AUGER TEST HOLE MET REFUSAL AT 5.5 FEET ON 05/31/2017
HAND AUGER TWO		
0.0 – 4.0		DARK BROWN TO BROWN SILTY FINE TO MEDIUM SAND WITH FINE GRAVEL AND 1/4-INCH ROOTS (LOOSE, DRY) (**FILL**)
4.0 – 5.5		RED-BROWN SILTY FINE TO COARSE SAND (LOOSE, DRY) (**FILL**)
5.5 – 9.2	SM	GRAY-BROWN SILTY FINE TO MEDIUM SAND WITH FINE GRAVEL (MEDIUM DENSE, MOIST-WET)
		SAMPLES WERE COLLECTED AT 3.2, 4.3, 6.0, AND 7.0 FEET MINOR GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 8.7 FEET CAVING WAS NOT ENCOUNTERED HAND AUGER TEST HOLE COMPLETED AT 9.2 FEET ON 05/31/2017
HAND AUGER THREE		
0.0 – 0.7		DARK BROWN SILTY FINE TO MEDIUM SAND WITH FINE GRAVEL AND 1/4-INCH ROOTS (LOOSE, MOIST-WET) (**FILL**)
0.7 – 1.1		GRAY-BROWN SILTY FINE TO MEDIUM SAND WITH TRACE FINE GRAVEL AND ORGANIC DEBRIS AND IRON OXIDATION STAINING (LOOSE, MOIST) (**FILL**)
1.1 – 3.1	SM	DARK BROWN SILTY FINE TO MEDIUM SAND (LOOSE-MEDIUM DENSE, MOIST-WET)
3.1 – 5.0	SM	GRAY-BROWN SILTY FINE TO MEDIUM SAND (MEDIUM DENSE, WET)
		SAMPLES WERE COLLECTED AT 2.0 AND 3.1 FEET MINOR GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 4.5 FEET CAVING WAS NOT ENCOUNTERED HAND AUGER TEST HOLE MET REFUSAL AT 5.0 FEET ON 05/31/2017
HAND AUGER FOUR		
0.0 – 2.4		DARK BROWN SILTY FINE TO MEDIUM SAND WITH FINE GRAVEL AND 1/4-INCH ROOTS (LOOSE, MOIST) (**FILL**)
2.4 – 4.2	SM	GRAY-BROWN SILTY FINE TO MEDIUM SAND WITH FINE GRAVEL AND TRACE IRON OXIDATION STAINING (MEDIUM DENSE, MOIST-WET)
		SAMPLES WERE COLLECTED AT 2.4 FEET MODERATE GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 3.7 FEET CAVING WAS NOT ENCOUNTERED HAND AUGER TEST HOLE COMPLETED AT 4.2 FEET ON 05/31/2017

LOG OF EXPLORATION

DEPTH (FEET)	USC	SOIL DESCRIPTION
HAND AUGER FIVE		
0.0 – 2.3		DARK BROWN SILTY FINE TO MEDIUM SAND WITH FINE GRAVEL AND 1/2-INCH ROOTS (LOOSE, WET) (**FILL**)
2.3 – 3.2	SM	GRAY-BROWN SILTY FINE TO MEDIUM SAND WITH FINE GRAVEL AND TRACE IRON OXIDATION STAINING (MEDIUM DENSE, MOIST-WET)

SAMPLES WERE COLLECTED AT 2.3 FEET
MODERATE GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 3.1 FEET
CAVING WAS NOT ENCOUNTERED
HAND AUGER TEST HOLE COMPLETED AT 3.2 FEET ON 05/31/2017

LOG OF EXPLORATION

DEPTH (FEET)	USC	SOIL DESCRIPTION
TEST PIT ONE		
0.0 – 1.7		TOPSOIL
1.7 – 3.4	SM	BROWN SILTY FINE TO MEDIUM SAND WITH GRAVEL (LOOSE TO MEDIUM DENSE, MOIST) **(WEATHERED TILL)**
3.4 – 5.8	SM	RUST-BROWN MOTTLED GRAY SILTY FINE TO MEDIUM SAND WITH GRAVEL (MEDIUM DENSE, MOIST TO WET) **(WEATHERED TILL)**
5.8 – 6.8	SP	GRAY MEDIUM TO COARSE SAND WITH SILT (MEDIUM DENSE, WET) **(ADVANCE OUTWASH)**
		SAMPLES WERE COLLECTED AT 2.8, 4.4, AND 6.0 FEET MODERATE GROUND WATER SEEPAGE WAS ENCOUNTERED BELOW 5.8 FEET MODERATE TEST PIT CAVING WAS ENCOUNTERED BELOW 5.8 FEET TEST PIT WAS COMPLETED AT 6.8 FEET ON 5/8/03
TEST PIT TWO		
0.0 – 3.0	SM	BROWN SILTY FINE TO MEDIUM SAND WITH GRAVEL, ORGANICS, AND ROOTS (LOOSE, MOIST) **(FILL)**
3.0 – 3.3		TOPSOIL
3.3 – 4.2	SM	BROWN SILTY FINE TO MEDIUM SAND WITH GRAVEL (LOOSE TO MEDIUM DENSE, MOIST) **(WEATHERED TILL)**
4.2 – 5.8	SP	GRAY-BROWN MEDIUM SAND WITH SILT (MEDIUM DENSE, MOIST) **(DRIFT)**
5.8 – 6.3	ML	RUST-BROWN MOTTLED GRAY SILT WITH FINE TO MEDIUM SAND AND FINE GRAVEL (STIFF, MOIST) **(DRIFT)**
		SAMPLES WERE COLLECTED AT 3.4, 5.3, AND 6.0 FEET GROUND WATER SEEPAGE WAS NOT ENCOUNTERED TEST PIT CAVING WAS NOT ENCOUNTERED TEST PIT WAS COMPLETED AT 6.3 FEET ON 5/8/03