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April 17, 2023

Ms. Joanna Yee
Via Email: **Joanna_yee@hotmail.com**

Geotechnical Engineering Evaluation
Yee 92nd Place SE Residence Addition Development
7405 – 92nd Place SE
Mercer Island, Washington
NGA File No. 1434423

Dear Ms. Yee:

We are pleased to submit the attached report titled ***"Geotechnical Engineering Evaluation – Yee 92nd Place SE Residence Addition Development – 7405 - 92nd Place SE – Mercer Island, Washington."*** This report summarizes our observations of the existing surface and subsurface conditions within the site, our observations and provides general recommendations for the proposed site development. Our services were completed in general accordance with the proposal signed by you on March 17, 2023.

The site is currently occupied by a single-family residence within the central portion of the property. The ground surface within the property is generally gently to moderately sloping down from the northwest to the southeast. A steep east-facing slope is located within the very western portion of the property that descends from the neighboring property to the west to the western portion of the subject property. Review of the City of Mercer Island GIS website indicates that property is located within several critical areas including potential slide, seismic and erosion hazard areas. The steep east-facing slope within the very western portion of the property is also designated as a steep slope hazard area. We understand the proposed improvements within the property will consist of interior improvements to the residence and construction of a new foyer addition within the south-central portion of the residence.

We conducted two hand auger explorations within the proposed development area. Our hand auger explorations extended down to depths in the range of 6.5 to 9.5 feet below the existing ground surface. Our explorations indicated that the proposed development area is generally underlain by surficial undocumented fill soils with competent native glacial soils depth.

It is our opinion that the proposed site development is feasible from a geotechnical engineering standpoint, provided that our recommendations for site development are incorporated into the project plans. It is also our opinion that the soils that underlie the site and form the core of the site slopes within the site should be stable with respect to deep-seated earth movements, due to their inherent strength and slope geometry. However, shallow failures could occur on the slopes in the loose surficial soil, especially during adverse weather or a significant seismic event. In general, the native glacial soils underlying the proposed development area should adequately support the planned structures.

Foundations should be advanced through any loose and/or undocumented fill soils down to the competent glacial soils interpreted to underlie the site, for bearing capacity and settlement considerations. These soils should generally be encountered approximately 2.0 to 7.5 feet below the existing ground surface, based on our explorations. If undocumented fill is encountered in unexplored areas of the site, it should be removed and replaced with structural fill for foundation support. If the overall site grades are proposed to not change significantly, it may become difficult to fully extend foundations down to competent native bearing soils encountered at depth while maintaining temporary excavation stability throughout the site. To limit potential overexcavations, the proposed addition foundations could alternatively be supported on 2-inch diameter driven steel pin piles extending through the fill and terminating within the underlying competent native glacial soils. We recommend that NGA be retained to review the proposed grading plans once they are developed.

In the attached report, we have also provided general recommendations for site grading, slabs-on-grade, structural fill placement, retaining walls, erosion control, and drainage. We should be retained to review and comment on final development plans and observe the earthwork phase of construction. 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.

It has been a pleasure 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 Engineer

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INTRODUCTION

The site is currently occupied by a single-family residence within the central portion of the property. The ground surface within the property is generally gently to moderately sloping down from the northwest to the southeast. A steep east-facing slope is located within the very western portion of the property that descends from the neighboring property to the west to the western portion of the subject property. Review of the City of Mercer Island GIS website indicates that property is located within several critical areas including potential slide, seismic and erosion hazard areas. The steep east-facing slope within the very western portion of the property is also designated as a steep slope hazard area. We understand the proposed improvements within the property will consist of interior improvements to the residence and construction of a new foyer addition within the south-central portion of the residence.

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. Review available soil and geologic maps of the area, as well as other documentation pertaining to the site.
2. Explore the subsurface soil and groundwater conditions within the property with hand auger explorations.
3. Map the conditions on the site slopes, perform shallow hand-tool excavations, and evaluate current slope stability conditions, as needed.
4. Provide recommendations for site grading and earthwork, including structural fill.
5. Provide recommendations for foundation support and slab-on-grade subgrade preparation.
6. Provide recommendations for temporary and permanent slopes.
7. Provide recommendations for site drainage and erosion control.
8. Provide recommendations for long-term slope maintenance, and erosion control, as needed.
9. Document the results of our findings, conclusions, and recommendations in a written geotechnical report.

SITE CONDITIONS

Surface Conditions

The site consists of an irregular-shaped parcel covering approximately 0.31 acres. The site is currently occupied by a single-family residence within the central portion of the property. The ground surface within the property is generally gently to moderately sloping down from the northwest to the southeast. A steep east-facing slope is located within the very western portion of the property that descends from the neighboring property to the west to the top of an approximately six-foot tall rockery within the western portion of the subject property at an inclination of 26 degrees (49 percent) as shown in Cross-Section A-A' in Figure 3. The site is vegetated with grass, landscaping plants and young to mature trees. The site is bordered to the north, east and west by existing residence properties, and to the south by 92nd Place SE. We did not observe any standing water within the site or groundwater seepage within the site slopes during our site visit on March 24, 2023. We also did not observe significant signs of recent slope movement within the site slopes during our site visit. The existing site conditions and proposed development areas are shown on the Site Plan in Figure 2.

Subsurface Conditions

Geology: The geologic units for this area are shown on the Geologic Map of Mercer Island, Washington, by Kathy G. Troost & Aaron P. Wisher, et al. (USGS, October 2006). The site is mapped as Recessional Outwash (Qvr). The recessional outwash is described as stratified sand and gravel soils. Our explorations generally encountered undocumented fill soils underlain by sand with silt and gravel soils that we interpreted as recessional outwash deposits.

Explorations: We visited the site on March 24, 2023 to explore the subsurface conditions within the proposed development area with two hand auger explorations. The approximate locations of our explorations are shown on the Schematic Site Plan in Figure 2. A geologist from Nelson Geotechnical Associates, Inc. (NGA) was present during the explorations, examined the soils and geologic conditions encountered, and maintained logs of the explorations. The soils were visually classified in general accordance with the Unified Soil Classification System, presented in Figure 4. The logs of our explorations are presented as Figure 5. The following paragraph contains a brief description of the subsurface conditions encountered in the explorations. For a detailed description of the subsurface conditions, the hand auger logs should be reviewed.

Underlying the ground surface within all of our hand auger explorations, we encountered approximately 2.0 to 7.5 feet of loose, dark brown-gray silty fine to medium sand with gravel and varying amounts of organics that we interpreted as surficial topsoil and/or undocumented fill soils. The undocumented fill soils encountered at depth within Hand Auger 2 are likely associated with the subsurface basement retaining wall backfill. Underlying the fill soils in each of our explorations, we encountered dense, gray-brown to gray fine to coarse sand with varying amounts of silt and gravel that we interpreted as native glacial recessional outwash soils. Each of our hand auger explorations were terminated within the native glacial outwash soils at depths in the range of 6.5 to 9.5 feet below the existing ground surface.

Hydrogeologic Conditions

We did not encounter groundwater seepage in explorations completed within the site. If seepage were to be encountered on the site, we would interpret this water to be perched groundwater. Perched water occurs when surface water infiltrates through less dense, more permeable soils and accumulates on top of underlying, less permeable 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 precipitation. We would expect the amount of perched water to decrease during drier times of the year and increase during wetter periods.

SENSITIVE AREA EVALUATION

Seismic Hazard

We reviewed the 2018 International Building Code (IBC) and the ASCE 7-16 for seismic site classification for this project. Since competent glacial soils were encountered at depth within the subject site, the site conditions best fit the IBC description for Site Class D. **Table 1** below provides seismic design parameters for the site that are in conformance with the 2018 IBC, which specifies a design earthquake having a two percent probability of occurrence in 50 years (return interval of 2,475 years), and the 2014 USGS seismic hazard maps.

Table 1 – ASCE 7-16 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	1.456	0.503	1.0	null	0.971	null

The spectral response accelerations were obtained from the USGS Earthquake Hazards Program Interpolated Probabilistic Ground Motion website (2014 data) for the project latitude and longitude.

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

Erosion Hazard

The criteria used for determination of the erosion hazard for affected 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 Natural Resources Conservation Service (NRCS) lists the site as Everett-Alderwood gravelly sandy loam, 0 to 8 percent slopes. The erosion hazard is not listed but based on our observations and the material encountered, we would interpret this site as having a low erosion hazard where the surficial soils are exposed. It is our opinion that the erosion hazard for site soils should be low in areas where the site is not disturbed.

Landslide Hazard/Slope Stability

The criteria used for evaluation of landslide hazards include soil type, slope gradient, and groundwater conditions. The ground surface within the property is generally gently to moderately sloping down from the northwest to the southeast. A steep east-facing slope is located within the very western portion of the property that descends from the neighboring property to the west to the top of an approximately six-foot tall rockery within the western portion of the subject property at an inclination of 26 degrees (49 percent) as shown in Cross-Section A-A' in Figure 3. We did not observe evidence of significant slope instability within or within the immediate vicinity of the property during our investigation, such as deep-seated landsliding. We also did not observe groundwater seepage or signs of erosion or sloughing on the site slopes at the time of our visit.

The core of the slope is inferred to consist primarily of dense or better native glacial soils. Relatively shallow sloughing failures as well as surficial erosion are natural processes and should be expected on the steeper site 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 slope, there is not a significant potential for deep-seated slope failures under current site conditions. Proper site grading and drainage as well as adequate foundation placement as recommended in this report should help maintain current stability conditions.

CONCLUSIONS AND RECOMMENDATIONS

General

It is our opinion that the planned residence addition construction within this property 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 within the western portion of the property should be stable with respect to deep-seated earth movements, due to their inherent strength and slope geometry. However, shallow failures could occur on the slopes in the loose surficial soil, especially during adverse weather or a significant seismic event. Proper foundation construction and placement, erosion and drainage control measures as recommended in this report should reduce the impact of such events on the proposed development. Our explorations indicated that the site was underlain by surficial undocumented fill soils with medium dense to dense glacial outwash soils at depth within the proposed development area. These competent glacial soils should provide adequate support for foundation and slab loads. We recommend that the structure be designed utilizing conventional shallow foundations. Footings should extend through any loose surficial soil and be keyed into the underlying competent native soils. These soils should be encountered roughly 2.0 to 7.5 feet below the existing ground surface within the proposed development area with some potential localized areas of deeper loose soils closer to the lower basement retaining wall and/or in unexplored areas of the site.

If the proposed overall site grades are proposed to not change significantly, it may become difficult to fully extend foundations down to competent native bearing soils encountered at depth while maintaining temporary excavation stability throughout the site. Alternatively, we recommend that the new structure foundations could be supported on a deep foundation system consisting of 2-inch diameter driven steel pin piles extending through the fill and terminating within the underlying competent native glacial outwash soils to limit potential overexcavation amounts within the site. We have provided recommendations for both options in the Foundations subsection of this report. We recommend that NGA be retained to review proposed grading plans once they are developed and be allowed to provide alternative foundation support recommendations as needed. Also, depending on final configuration, the existing basement wall may experience additional loading from the new addition, in which case, the structural engineer should review such potential and provide recommendations for minimizing impacts on the existing basement.

All grading operations and drainage improvements planned as part of this development should be planned and completed in a matter that enhances the stability of the site slopes, not reduces it. Excavation spoils associated with the building addition excavations should not be stockpiled near the slope 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 site slopes. Future vegetation management on the slopes should be the subject of a specific evaluation and a plan approved by the City of Mercer Island. The site slopes should be monitored on an ongoing 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 site slopes.

The soils encountered on this site are considered moisture-sensitive and will disturb easily when wet. To lessen the potential impacts of construction on the steep slope 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 new roof and yard drains be collected and tightlined to an approved 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 interpreted to be low, 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 site slopes. Stockpiles should be covered with plastic sheeting during wet weather and stockpiled material should be placed on or near sloping portions of the site. 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 slopes and buffer areas should be performed as required by City of Mercer Island code. Specifically, we recommend that the site slopes not be disturbed or modified through placement of any fill or removal of the existing vegetation. No material of any kind should be placed on the slope or be allowed to reach the slopes, such as excavation spoils, lawn clippings, and other yard waste, trash, or soil stockpiles. Trees should not be cut down or removed from the site slopes unless a mitigation plan is developed, such as the replacement of vegetation for erosion protection. Replacement of vegetation should be performed in accordance with City of Mercer Island code. Any proposed development within the vicinity of the site slope areas, 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 removing any hard surfaces and stripping any loose soils and undocumented fill to expose medium dense or better native soils in new foundation and slab-on-grade areas. The stripped materials should be removed from the site. 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, especially if grading is attempted in wet weather. These could include 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, as well as result in inadequate subgrades.

Temporary and Permanent Slopes

Final grading plans were not available at the time this report was prepared. However, temporary excavations may be required to construct the planned addition. Temporary excavation 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 1.5 Horizontal to 1 Vertical (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. Measures taken may include covering cut slopes with plastic sheeting and diverting surface runoff away from the top of cut slopes. Excavated material should not be stockpiled any closer than 10 feet from the top of the cuts. 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 WISHA/OSHA standards. 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. However, flatter inclinations may be required in areas where loose soils are encountered. Permanent slopes should be planted, and the vegetative cover should be maintained until it is established. We should review plans and visit the site to evaluate excavations for this project.

Foundation Support

Shallow Foundation Support: Conventional shallow spread foundations should be placed on undisturbed medium dense or better native soils or structural fill extending to these soils. Medium dense to dense soils should be encountered roughly 2.0 to 7.5 feet below the ground surface based on our explorations in the proposed development areas; however, localized deeper areas of loose soil may be encountered especially in areas closer to the lower basement retaining walls. Where undocumented fill or less dense soils are encountered at footing bearing elevation, the subgrade should be over-excavated to expose suitable bearing soil.

The residence addition foundations should be supported on the competent native glacial soils and 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 2018 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. 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 ½-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.

Deep Foundation Support: Due to the anticipated depth of the unsuitable fill soils within portions of the proposed development area, alternatively, we recommend that the proposed addition structure could be supported on a deep foundation system to transfer structure loads down into the underlying competent bearing materials. In our opinion, the most feasible deep foundation support systems will consist of 2-inch diameter pin piles driven to refusal. A structural engineer should design the new foundation supports and determine the location of the supports based on the recommendations provided in this report. The number and spacing of the piles should be determined by the structural engineer based on anticipated loading and recommended design axial compression capacity for the piles. The piles should be spaced a minimum of three pile diameter apart to avoid a grouping effect on the piles. For 2-inch diameter pipe piles driven to refusal using a hand-held, 140-pound jackhammer, we recommend a design axial compression capacity of three tons for each pile. The piles should be embedded a minimum of 5 feet into competent material after advancing through the fill. Piles that do not meet this minimum embedment criterion should be rejected, and replacement piles should be driven after consulting with the structural engineer on the new pile locations. The piles could consist of 2-inch diameter galvanized extra strong *(Schedule 80)* steel pipe sections.

Our explorations encountered loose undocumented fills within the planned development area. If large objects or debris are present within the fill, there is a possibility that this material may obstruct some piles at shallow depths. There should be contingencies in the budget and design for additional/relocated piles that may be obstructed by possible debris in the fill.

Final pile depths should be expected to vary and will depend on the depth to competent bearing soils. Due to the limited nature of the explorations, we recommend that one or more “test” piles be installed to verify design parameters and estimate an approximate depth of the piles that will be needed for budgeting purposes.

Vertically driven pin piles do not provide meaningful lateral capacity. Due to the rigid pile support, friction between the foundation and subgrade soil should not be considered as resisting lateral pressures on this structure. We recommend that all lateral loads be resisted on battered pin piles and/or passive resistance on the below-grade portions of the foundations and grade beams. We recommend using an equivalent fluid density of 150 pcf for calculating the passive resistance. The upper foot of soil should be neglected when calculating the passive resistance.

NGA should be retained to review final plans and to monitor installation of the pin piles during construction.

Retaining Walls

Specific grading plans for this project were not available at the time this report was prepared, but if retaining walls are incorporated into project plans, they should be designed and constructed according to the following recommendations. 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 35 pcf for yielding (active condition) walls, and 55 pcf for non-yielding (at-rest condition) walls. A seismic design loading of 8H should also be included in the wall design, where "H" represents the total height of the wall.

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 the passive resistance acting on the below-grade portion of the foundation. Recommendations for 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 8-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.

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 could be used as structural fill, but that will highly depend on the moisture content of the material at the time of construction. 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. 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 and assist in curing the concrete.

Utilities

We recommend that underground utilities be bedded with a minimum six inches of pea gravel prior to backfilling the trench with on-site or imported material. Trenches within settlement sensitive areas should be compacted to 95% of the modified proctor as described in the **Structural Fill** subsection of this report. Trench backfill should be compacted to a minimum of 95% of the modified proctor maximum dry density within the roadway. Trenches located in non-structural areas should be compacted to a minimum 90% of the maximum dry density. Trench backfill compaction should be tested.

Site Drainage

Surface Drainage: The finished ground surface should be graded such that runoff is directed away from the residence and the slopes. Water should not be allowed to collect in any areas where footings, slabs, or pavements are to be constructed. Final site grades should allow for drainage away from the 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 structures.

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 from the excavation and routed to a suitable discharge point. Water should not be allowed to flow over the steep slope. Perched groundwater conditions are anticipated on this site and footing drains are recommended for this project. 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 covered with 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. Washed rock is an acceptable drain material. The free-draining material should extend behind any subsurface walls to one foot below the finished ground 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 approved 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. We also recommend that all residence downspouts and yard drains be investigated to understand where they are directed. At a minimum, we recommend that all residence downspouts and yard drains be tight lined and directed to discharge to an approved discharge location located within the roadway.

CONSTRUCTION MONITORING

We recommend that we be retained to provide construction monitoring services to evaluate conditions encountered in the field with respect to anticipated conditions, to provide recommendations for design changes should the conditions differ from anticipated, and to evaluate whether construction activities comply with contract plans and specifications.

CLOSURE

Based on our understanding of the proposed plans, and provided that the recommendations in our in this report are strictly followed during construction, the areas disturbed by construction should remain stable meeting the criteria stated in Mercer Island City Code 19.07.160.B.2.a-d. In addition, the development has been designed so that the risk to the lot and adjacent properties is eliminated or mitigated such that the site is determined to be safe, meeting the requirements stated in Mercer Island City Code 19.07.160.B.3.b.

USE OF THIS REPORT

NGA has prepared this report for **Ms. Joanna Yee** and her agents, for use in the planning and design of the proposed improvements 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. 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 on or near hillsides should realize that landslide movements are always a possibility. The landowner should periodically inspect the slope, 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 review final plans prior to construction. 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 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.

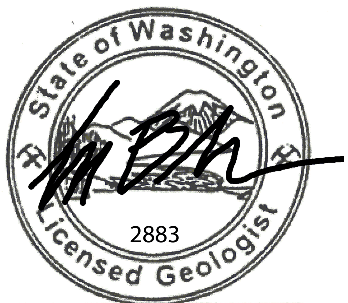
Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering practices in effect in this area at the time this report was prepared. No other warranty, expressed or implied, is made. Our observations, findings, and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

o-o-o

We appreciate the opportunity to provide service to you on this project. If you have any questions or require further information, please call.

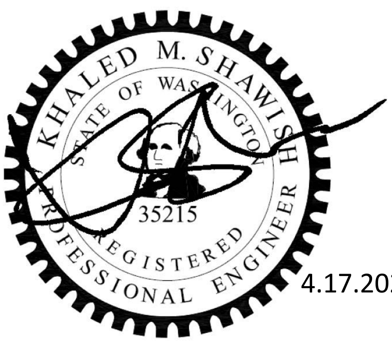
Sincerely,

NELSON GEOTECHNICAL ASSOCIATES, INC.



LEE S. BELLAH

Lee S. Bellah, LG
Project Geologist



4.17.2023

Khaled M. Shawish, PE
Principal

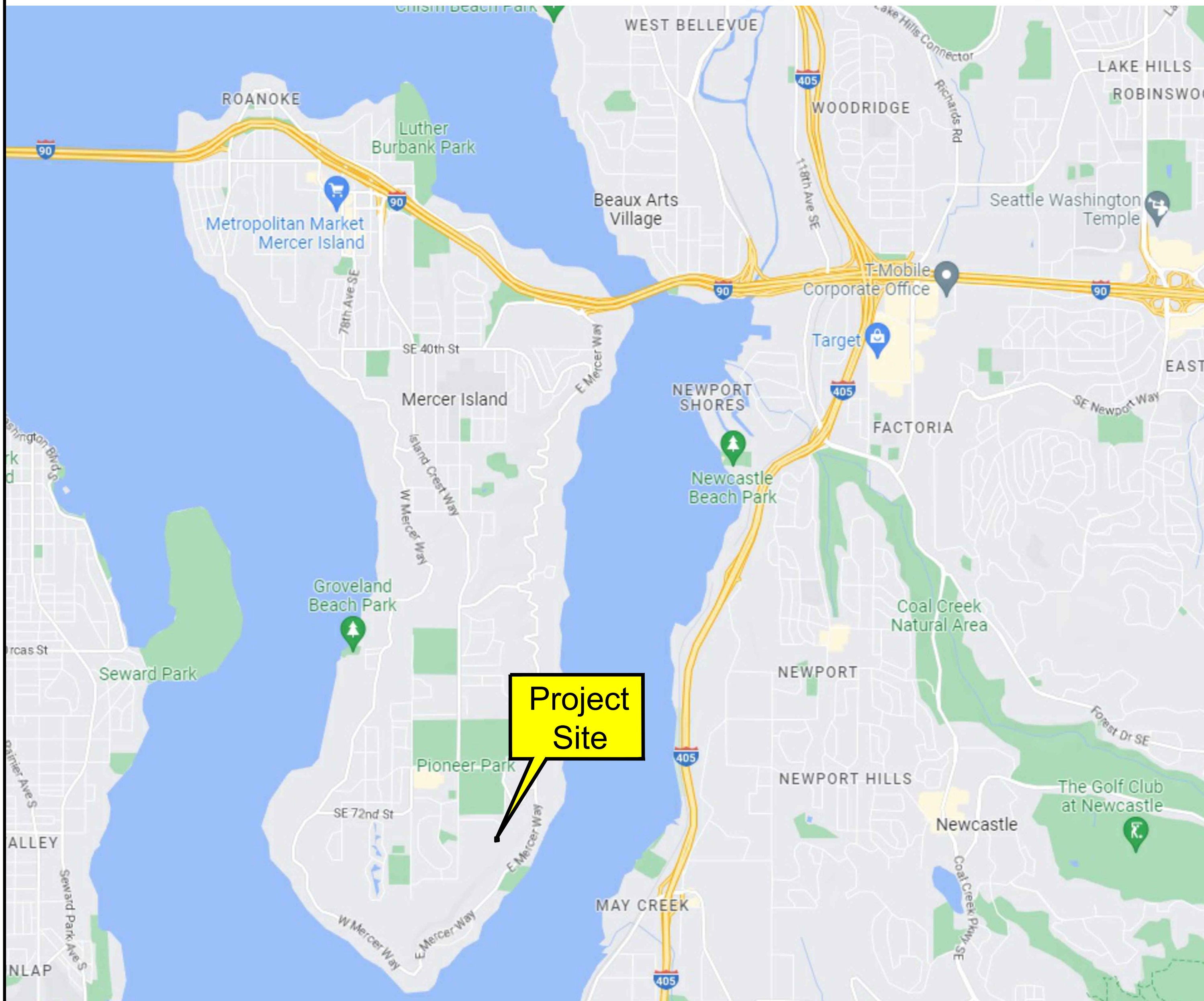
LSB:KMS:dy

Five Figures Attached

VICINITY MAP

Not to Scale

N



Mercer Island, WA

Project Number	Yee Residence Addition Development Vicinity Map	NELSON GEOTECHNICAL ASSOCIATES, INC	No.	Date	Revision	By	CK
1434423		Woodinville Office 17311-135th Ave. NE, A-500 Woodinville, WA 98072 (425) 486-1669 / Fax: 481-2510	1	3/29/23	Original	FKS	LSB
Figure 1		Wenatchee Office 105 Palouse St. Wenatchee, WA 98801 (509) 665-7696 / Fax: 665-7692					
		www.nelsongeotech.com					

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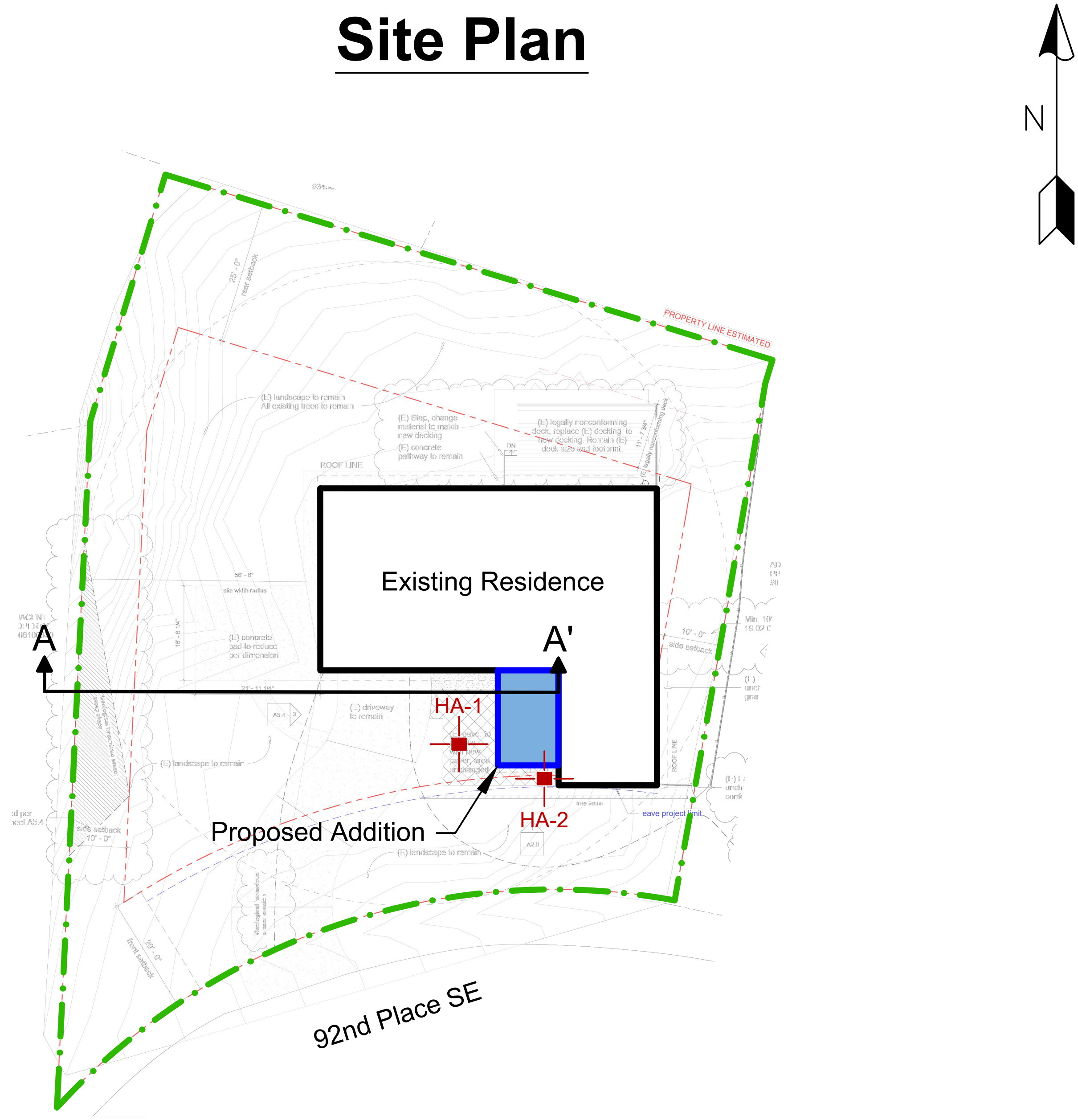
Site Plan



LEGEND

Property line

HA-1 — Number and approximate location of hand auger

A — A' Approximate location of cross-section

0 30 60

Scale: 1 inch = 30 feet

Reference: Site Plan based on a plan dated February 11, 2023 titled "7405 Tarywood," provided by 5ft2 Studio Architects .

Project Number 1434423	Yee Residence Addition Development Site Plan	NELSON GEOTECHNICAL ASSOCIATES, INC	No.	Date	Revision	By	CK
Figure 2		Woodinville Office 17311-135th Ave. NE, A-500 Woodinville, WA 98072 (425) 486-1669 / Fax: 481-2510; Wenatchee Office 105 Palouse St. Wenatchee, WA 98801 (509) 665-7696 / Fax: 665-7692; www.nelsongeotech.com	1	3/30/23	Original	FKS	LSB

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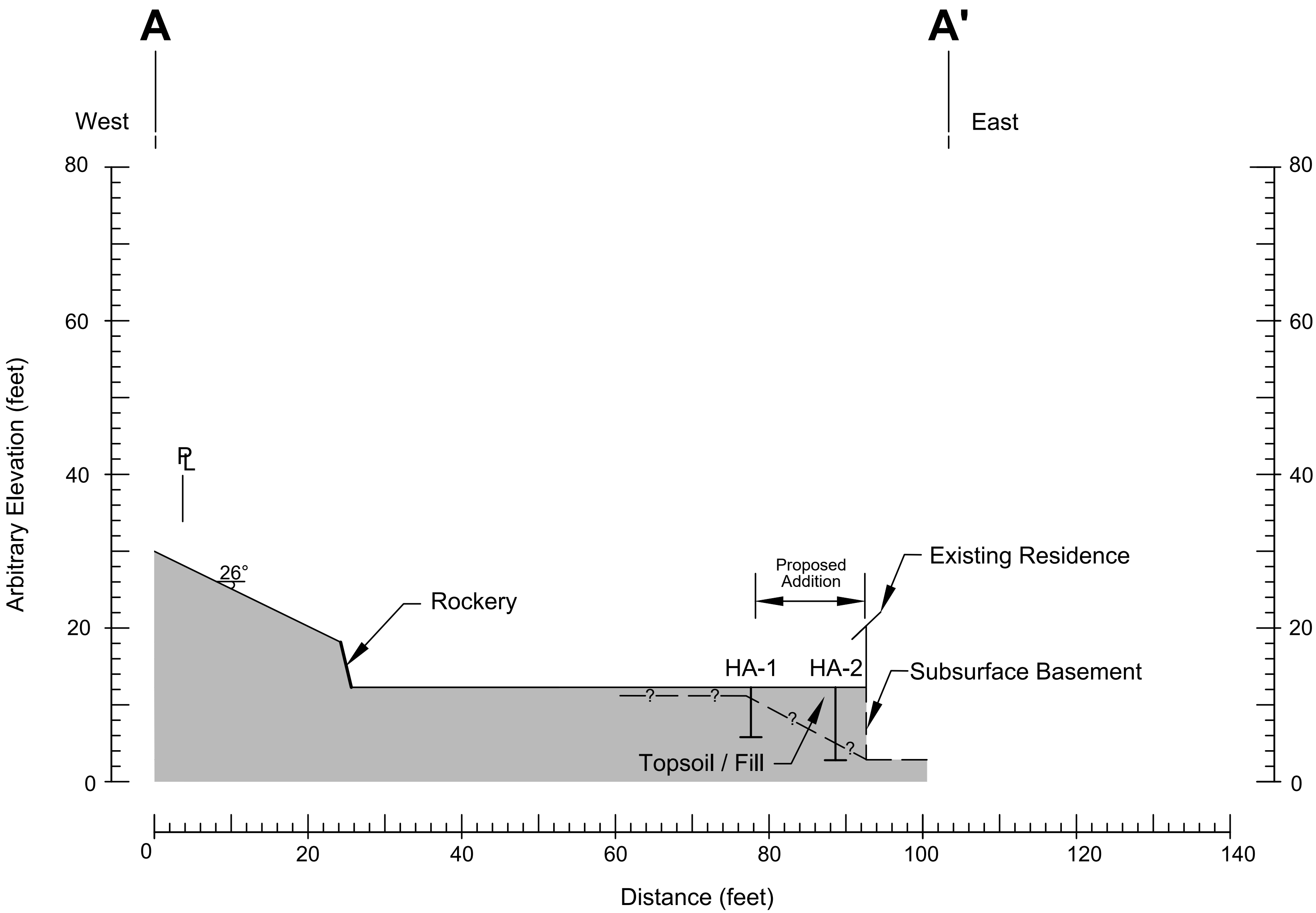
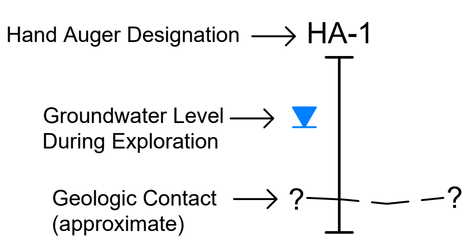


Exploration



NOTES:

1) Stratigraphic conditions are interpolated between the explorations. Actual conditions may vary.
2) Elevations are arbitrary.

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

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No.	Date	Revision	By	CK
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www.nelsongeotech.com

Yee Residence
Addition Development
Cross-Section A-A'

Project Number
1434423

Figure 3

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, FAT 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	Yee Residence Addition Development Soil Classification Chart	NELSON GEOTECHNICAL ASSOCIATES, INC
1434423		
Figure 4		

NGA
NELSON GEOTECHNICAL ASSOCIATES, INC

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No.	Date	Revision	By	CK
1	3/30/23	Original	FKS	LSB

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LOG OF EXPLORATION

DEPTH (FEET)	USCS	SOIL DESCRIPTION
HAND AUGER ONE		
0.0 – 0.5		**TOPSOIL**
0.5 – 2.0		DARK GRAY-BROWN, SILTY, FINE TO MEDIUM SAND WITH ORGANICS (LOOSE, MOIST) (**FILL**)
2.0 – 6.5	SP-SM	GRAY, FINE TO COARSE SAND WITH SILT AND GRAVEL (DENSE, MOIST)
		SAMPLE WAS COLLECTED AT 4.0 FEET GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED HAND AUGER CAVING WAS NOT ENCOUNTERED HAND AUGER WAS COMPLETED AT 6.5 FEET ON 3/24/2023
HAND AUGER TWO		
0.0 – 1.0		**TOPSOIL**
1.0 – 7.5		DARK GRAY-BROWN, SILTY, FINE TO COARSE SAND WITH GRAVEL AND ORGANICS (LOOSE, MOIST) (**FILL**)
7.5 – 9.5	SP	GRAY-BROWN, FINE TO MEDIUM SAND WITH GRAVEL (DENSE, MOIST)
		SAMPLE WAS COLLECTED AT 6.0 FEET GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED HAND AUGER CAVING WAS NOT ENCOUNTERED HAND AUGER WAS COMPLETED AT 9.5 FEET ON 3/24/2023