NELSON GEOTECHNICAL ASSOCIATES, INC.
GEOTECHNICAL ENGINEERS & GEOLOGISTS

Main Office
17311 – 135th Ave NE, A-500
Woodinville, WA 98072
(425) 486-1669 · FAX (425) 481-2510

Engineering-Geology Branch
5526 Industry Lane, #2
East Wenatchee, WA 98802
(509) 665-7696 · FAX (509) 665-7692

February 17, 2017

Sam Bull and Lam Nguyen-Bull
5460 East Mercer Way
Mercer Island, Washington 98040

Geotechnical Engineering Evaluation
Bull Residence Addition
5460 East Mercer Way
Mercer Island, Washington
NGA File No. 981417

Dear Mr. Bull and Mrs. Nguyen-Bull:

This report summarizes our evaluation and recommendations for the proposed addition and improvements to the residence located at 5460 East Mercer Way on Mercer Island, Washington, as shown on the Vicinity Map in Figure 1. Our services were completed in general accordance with our proposal signed by you on January 24, 2017.

INTRODUCTION

We visited the site on January 31, 2017 to observe the existing site conditions. The site is currently occupied by a single-family residence with a daylight basement. The ground surface within the site slope gently to moderately sloping from the western property boundary down to the eastern property boundary along the western shore of Lake Washington. We understand that the proposed development includes adding an upper story to the existing residence along with a new two-story addition along the northeast corner of the existing residence. The existing and proposed conditions are shown on the Site Plan in Figure 2.

For our use, we have been provided with a site plan and floor plan sheets dated January 4, 2017, and prepared by Babienko Architecture, PLLC.

SITE CONDITIONS

Surface Conditions

The property consists of an irregular-shaped parcel covering approximately 0.52 acres as shown on the Site Plan in Figure 2. The site is currently occupied by an existing single-family residence with a daylight basement within the central portion of the property. The site is accessed via a paved driveway that extends to the north to the residence from the southeast corner of the property. The site is generally situated on gently to moderately sloping ground that descends from the western property line to the eastern property line along Lake Washington at gradients in the range of approximately 3 to 19 degrees (5 to 34 percent) as shown on Cross Section A-A' in Figure 3. The vertical relief through the property is approximately 35 to 40 feet. The property around the residence is generally covered with grass, landscaping plants, and young to mature trees. The property is bordered to the north, south and west by existing residential properties, and to the east by Lake Washington. We did not observe surface water on the site or seepage on the site slopes during our site visit on January 31, 2017. We also did not observe significant signs of recent slope movement.

We did not observe any indications of significant distress or settlement within the existing residence foundation or exposed slab-on-grades within the residence. However, we did observe some significant cracking and settlement within the hard surfaces surrounding the existing residence. We were informed and observed subsurface drainage issues within the western basement area. It appears that water seeps through the existing basement retaining walls within the western portion of the residence and collects on the basement slab. We were unable to determine the exact location and extent of the groundwater within the basement area.

Based on our exploration along the eastern portion of the residence, it appears that the residence foundation may be six feet deep or greater below the existing ground surface. We were unable to expose the base of the foundation in this area due to the overall depth. Due to site constraints, we were also not able to expose any other residence foundations.

Subsurface Conditions

Geology: The geologic units for this area are mapped on the Geologic Map of Mercer Island, Washington by Kathy G. Troost and Aaron P. Wisher, (University of Washington, 2006). The project site is mapped as surficial deposits, consisting of nonglacial deposits (Qpon) and lake deposits (Ql). The Qpon deposits are described as sand, gravel, silt, clay, and organic deposits of inferred nonglacial origin, present near the lake level. The lake deposits are described as silt and clay with local sand layers deposited adjacent to Lake Washington and exposed in 1916 when the lake level was lowered. Our explorations generally encountered undocumented fill soils with some explorations encountering silty fine to medium sand soils consistent with the description of nonglacial deposits at depth.

Explorations: We visited the site on January 31, 2017 to explore the subsurface conditions within the proposed development areas with hand auger explorations. The approximate locations of our explorations are shown on the 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 through 7. 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.

In Hand Augers 1, 3, 4, 5, and 7 through 9, we encountered approximately 0.2 to 1.3 feet of loose, dark brown, silty fine to medium sand with varying amounts of gravel and organics that we interpreted as topsoil. Hand Augers 2 and 6 encountered 0.6 to 0.7 feet of concrete, asphalt and brick overlying the surface. Underlying the topsoil in Hand Augers 1, 3, 4, 5, and 7 through 9, the surficial hard surfacing in Hand Augers 2 and 6, and the ground surface in Hand Auger 10, we encountered loose to medium dense dark brown to gray fine to medium sand with varying amounts of silt, gravel, organics and debris that we interpreted as undocumented fill soils. In Hand Augers 2, 3, and 9, we encountered medium dense to dense, gray silty fine to medium sand with gravel that we interpreted as native soils at depths of 3.5, 4.5, and 3.0 feet below the existing ground surface, respectively. Hand Augers 1, 4 through 8, and 10 all met refusal within the undocumented fill soils at depths in the range of 2.5 to 7.3 feet below the existing ground surface. Hand Augers 2, 3, and 9 met refusal within the native site soils at depths of 7.0, 4.0 and 4.2 feet below the existing ground surface, respectively.

Hydrologic Conditions

We encountered groundwater seepage in Hand Augers 2 and 9 at depths in the range of 4.0 and 6.0 feet below the existing ground surface. We 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. However, we anticipate that a groundwater table associated with Lake Washington to the east could be encountered at depth below the site.

SENSITIVE AREA EVALUATION

Seismic Hazard

We reviewed the 2015 International Building Code (IBC) for seismic site classification for this project. Since medium dense or better soils interpreted to underlie the site at depth fit the IBC description for Site Class D.

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.

The competent soils interpreted to form the core of the site slopes are considered stable with respect to deep-seated slope failures. However, the loose surficial materials and undocumented fill soils on the site slopes have the potential for shallow sloughing failures during seismic events. Such events should not affect the planned addition provided the addition is designed in accordance with the recommendation presented in this report.

Erosion Hazard

The criteria used for determining the erosion hazard for the site soils includes 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) was reviewed to determine the erosion hazard of the on-site soils. The site surface soils were classified using the SCS classification system as Kitsap silt loam, 2 to 8 percent slopes (KpB) and 15 to 30 percent slopes (KpD). These soils are listed as having a slight to severe hazard of water erosion. These soils should have a low to moderate hazard for erosion in areas that are not disturbed and where the vegetation cover is not removed.

Landslide Hazard/Slope Stability

The criteria used for evaluation of landslide hazards include soil type, slope gradient, and groundwater conditions. The site is generally situated on a gentle to moderate east-facing slope descending from the west to the east at gradients in the range of 3 to 19 degrees (5 to 34 percent). We did not observe significant evidence of past deep-seated slopes instability or major erosion or sloughing events on the site slopes during our site visit. We also did not observe indications of seepage on the slopes during our visit.

The core of the site slope is inferred to consist primarily of competent native soils. Relatively shallow sloughing failures as well as surficial erosion are natural processes and should be expected on the steeper slopes within the property 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 slope, there is not a significant potential for deep-seated slope failure under current site conditions. Proper site grading, drainage, and foundation placement as recommended in this report should help reduce the impact of such events on the planned improvements.

CONCLUSIONS AND RECOMMENDATIONS

General

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. The gentle to moderate east-facing slopes are considered stable with respect to deep-seated failures. However, there is a potential for shallow sloughing and erosion events to occur on the slopes within the loose surficial and undocumented fill soils. During periods of extended rainfall and/or as a result of seismic activity, shallow slough-type failures may originate on the site slopes. This potential is considered low if the slope is not disturbed.

Our explorations indicated that the site is underlain by undocumented fill soils with medium dense or better native soils at depth. These native soils should provide adequate support for foundation, slab, and pavement loads. Our explorations within the proposed addition area along the northeast corner of the residence encountered at least six feet of unsuitable undocumented fill soils. Due to this condition, we anticipate that competent native soils are likely greater than six feet below the existing ground surface within the proposed addition area due to our explorations within this area not being able to extend below the undocumented fill soils. It is our opinion that the addition foundation could be designed utilizing shallow foundation extending through any loose surficial or undocumented fill soils and be supported directly on the underlying competent native soils interpreted to underlie the site at depth. We would anticipate excavations of six feet or greater if the proposed addition is to be supported on shallow foundations. Alternatively, the proposed addition could be supported on a deep foundation system consisting of pin piles extending through the fill and terminating within the underlying competent native soils. We recommend that the foundation elements for the proposed addition be supported on 2-inch or

4-inch diameter driven steel pin piles. In either case, we recommend that the addition foundations be designed to be completely independent of the existing residence foundations.

We were unable to expose the existing residence foundation within our explorations; however, the eastern foundation line appears to be at least six feet deep below the existing ground surface. We did not observe any significant distress or settlement within the residence foundation during our site visit. It appears that the existing residence foundation has performed adequately and it is our opinion that the existing foundation should be feasible to support the planned second story addition loads. We recommend that the structural engineer confirm the overall existing foundation design to confirm the existing foundation layout can support the planned loads.

We also recommend that all drainage features associated with this residence, such as roof downspouts, yard drains, footing drains, and runoff from any hard surfaces, be investigated and improved such that all runoff generated on this site is tighlined into an approved system. We did not observe evidence of foundation footing drains around the residence foundation. We recommend that footing drains should be installed around the perimeter of the residence and should be tightlined into the drainage system. Footing drains should consist of rigid perforated PVC pipes placed with trenches excavated down to the bottom of footing elevations, or at least 12 inches below bottom of slab elevations and backfilled with washed rock to roughly within 6 inches of the ground surface. The upper six inches of the trenches should be backfilled with low permeability material. Due to the serious drainage issues observed within the residence basement area, we recommend that significant waterproofing measures and drainage improvements be incorporated into the overall residence remodel. We can work with the project civil engineer to come up with the most feasible repairs as plans are developed.

The soils encountered on this site are considered moisture-sensitive and may 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 possible. If construction takes place during the rainy months, additional expenses and delays should be expected. These extra expenses could include additional erosion control and temporary drainage measures to protect the slope, placement of a blanket of rock spalls to protect exposed subgrades, and the need for importing all-weather materials for structural fill.

Under no circumstances, should water be allowed to flow over, or concentrate on the slope, both during construction and after construction has been completed. We recommend that stormwater runoff from the roof drains, paved areas, and yard drains be collected and tightlined to a suitable discharge point. The slope should be protected from erosion. We recommend that all disturbed areas be replanted with vegetation to re-establish vegetation as soon as possible. No fill or structures of any sort should be placed near the top of this slope without a specific evaluation. Stormwater runoff should not be allowed to concentrate or flow over the slopes.

Erosion Control and Slope Protection Measures

The erosion hazard for the on-site soils is considered to be slight to severe, 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 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, setback, and buffer areas should be performed as required by the City of Mercer Island. 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 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 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 as well as result in inadequate subgrades.

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 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 subsurface materials 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 2 Horizontal to 1 Vertical (2H: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.

Foundation Support

Shallow Foundations: Conventional shallow spread foundations should be placed on undisturbed medium dense or better native soils. We estimate that medium dense better soils should be encountered at least six feet or greater below the existing ground surface. Where undocumented fill or less dense soils are encountered at footing bearing elevation, the subgrade should be over-excavated to expose suitable bearing soil.

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. We should be retained to evaluate the foundation subgrade soils and embedment depths prior to placing foundation forms.

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.

In our opinion, the existing residence foundations appear to be performing well and are likely supported on competent native soils. It is also our opinion that the competent native soils supporting the existing foundations should provide suitable foundation design bearing capacities of not greater that 2,000 psf. We recommend that the structural engineer evaluate the existing residence foundation design and confirm that the existing residence foundation can support the anticipated new loads associated with the upper level addition.

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 0.30 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 Foundations: Due to the anticipated depth of the unsuitable fill soils within the addition area, alternatively, we recommend that the proposed addition be supported on a deep foundation system to transfer structure loads down into the underlying competent materials. In our opinion, the most feasible deep foundation support systems will consist of 2-inch or 4-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. We recommend that the proposed addition foundation be designed to be independent of the existing residence foundation.

For 2-inch diameter pipe piles driven to refusal using a hand-held, 140-pound jackhammer, we recommend a design axial compression capacity of two tons for each pile. The refusal criterion for this pile and hammer size is defined as less than one inch of movement during 60 seconds of continuous driving. We recommend using galvanized extra strong (Schedule 80) steel pipe.

If 4-inch pipe piles are utilized, we recommend that they be driven using a tractor-mounted hydraulic hammer, with an energy rating of at least 1,100 foot-lb. For this pile and hammer size, we recommend a design capacity of eight tons for each pile driven to refusal. The refusal criterion for this pile and hammer size is defined as less than one-inch of movement during 15 seconds of continuous driving at a rate of 550 blows per minute or higher. We recommend using galvanized schedule 40 pipe for the 4-inch pin piles. Maintaining these recommendations for minimum hammer size and refusal criteria is essential for obtaining a successful outcome.

Our explorations encountered loose undocumented fills within the planned addition 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 somewhat and will depend on the nature of the underlying soils. The pin piles should advance a minimum of 15 feet below current grade and also meet the above refusal criterion in order to provide the recommended design capacity. This should be determined in the field by the contractor under the supervision of NGA. 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. Due to the relatively small slenderness ratio of pin piles, maintaining pin pile confinement and lateral support is essential to preventing pile buckling.

Due to the rigid pile support, friction between the foundation and subgrade soil should not be considered for resisting lateral pressures on this structure. Also, passive resistance acting on the below-grade portion of the foundation should not be used to resist lateral pressures. We recommend that all lateral loads be transferred to the remainder of the structure. The slab should be designed to span the distance between the existing foundation and the new grade beams.

We 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 retaining walls may be incorporated into project plans. 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 45 pcf for yielding (active condition) walls, and 65 pcf for non-yielding (at-rest condition) walls. A seismic design loading of 8H in psf should also be included in the wall design where “H” is 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 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 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.

Slab-on-Grade

If no settlement of the proposed slab-on-grade can be tolerated, slabs-on-grade should be supported on competent native glacial soils or structural fill extending to these soils. The slabs could also be supported on pin piles as described above. If some potential settlement and cracking of the addition slab-on-grade can be tolerated, we recommend that the slab area be over-excavated by a minimum of two feet and replaced with crushed rock compacted to structural fill specifications and the new slab-on-grade supported directly on the crushed rock. The slab should be additionally reinforced and doweled cold joints incorporated into the slab to reduce the effects of differential settlement.

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.

Structural Fill

General: Fill placed beneath foundations, slabs, pavement, 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 of this report prior to beginning fill placement. Sloping areas to receive structural fill should be benched prior to fill placement to key the fill into the slope. The benches should be level and have a minimum width of six to eight feet. The benches should be constructed by cutting into the native sloping ground, then fill can be placed on the level benches.

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). The use of the on-site soils as structural fill is not recommended. 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 fill placements 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 underlying building areas and pavement subgrade 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.

Site Drainage

Surface Drainage: The finished ground surface should be graded such that runoff is directed away from the planned residence and the slope. 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.

We recommend the use of footing drains around the existing and proposed structures. Footing drains should be installed at least one-foot below planned finished floor elevation. The drains should consist of a minimum 4-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 drainage composite may be used instead. The free-draining material or the drainage composite should extend up the wall to one foot below the finished surface. The top foot of backfill 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 away from the slope, with convenient cleanouts to prolong the useful life of the drains. Roof drains should not be connected to wall or footing drains.

Due to drainage issues being experienced within the existing basement of the residence, we recommend that additional waterproofing measures be incorporated into the below-grade portions of the residence. These measures may include limiting cold-joints and wall penetrations, and/or installing bentonite sheeting or membranes along the exterior portions of the residence foundation. Adequate ventilation should also be incorporated into the remodel plans. We recommend that a specialized waterproofing contractor or consultant be retained to provide detailed recommendations regarding the overall waterproofing design to improve the drainage picture along the up slope side of the residence.

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 tightlined and directed to discharge at the bottom of the site or to a suitable discharge location.

USE OF THIS REPORT

NGA has prepared this report for Sam Bull and Lam Nguyen-Bull and their agents, for use in the planning and design of the improvements 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.

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.

All people who own or occupy homes on hillsides should realize that landslide movements are always a possibility. The homeowner 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.

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.

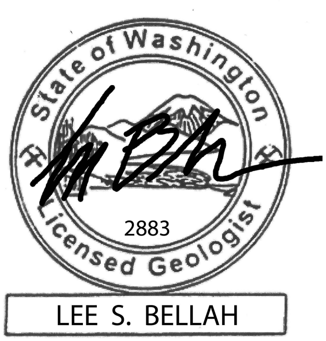
o-o-o

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.

Carston T. Curd, GIT
Staff Geologist



Lee S. Bellah, LG
Project Geologist

Khaled M. Shawish, PE
Principal

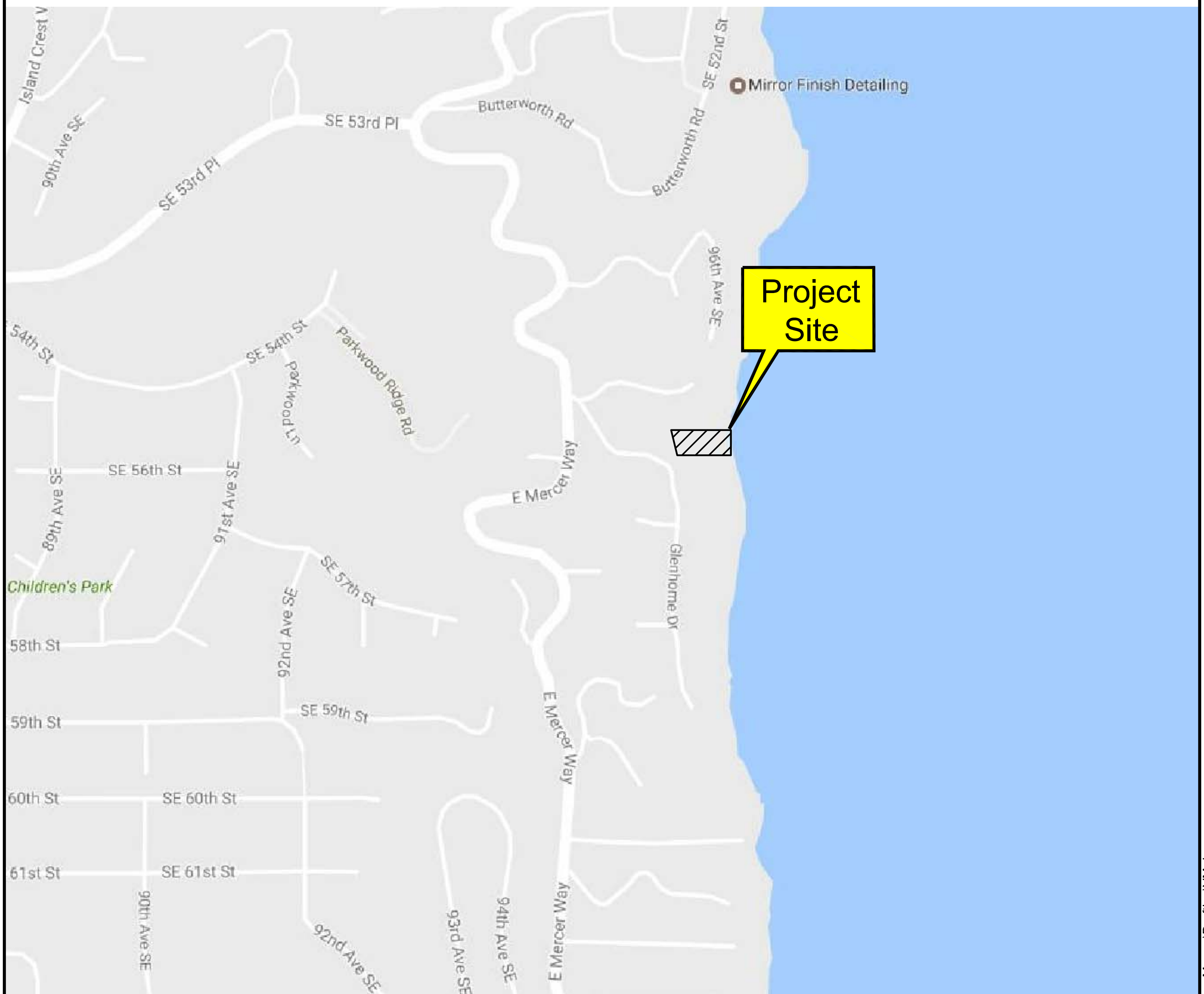
CTC:LSB:KMS:dy

Seven Figures Attached

VICINITY MAP

Not to Scale

N



Mercer Island, WA

Project Number 981417	Bull Residence Addition Vicinity Map	Nelson Geotechnical Associates, Inc.	No.	Date	Revision	By	CK
Figure 1		Geotechnical Engineers & Geologists	1	2/7/17	Original	DPN	KMS

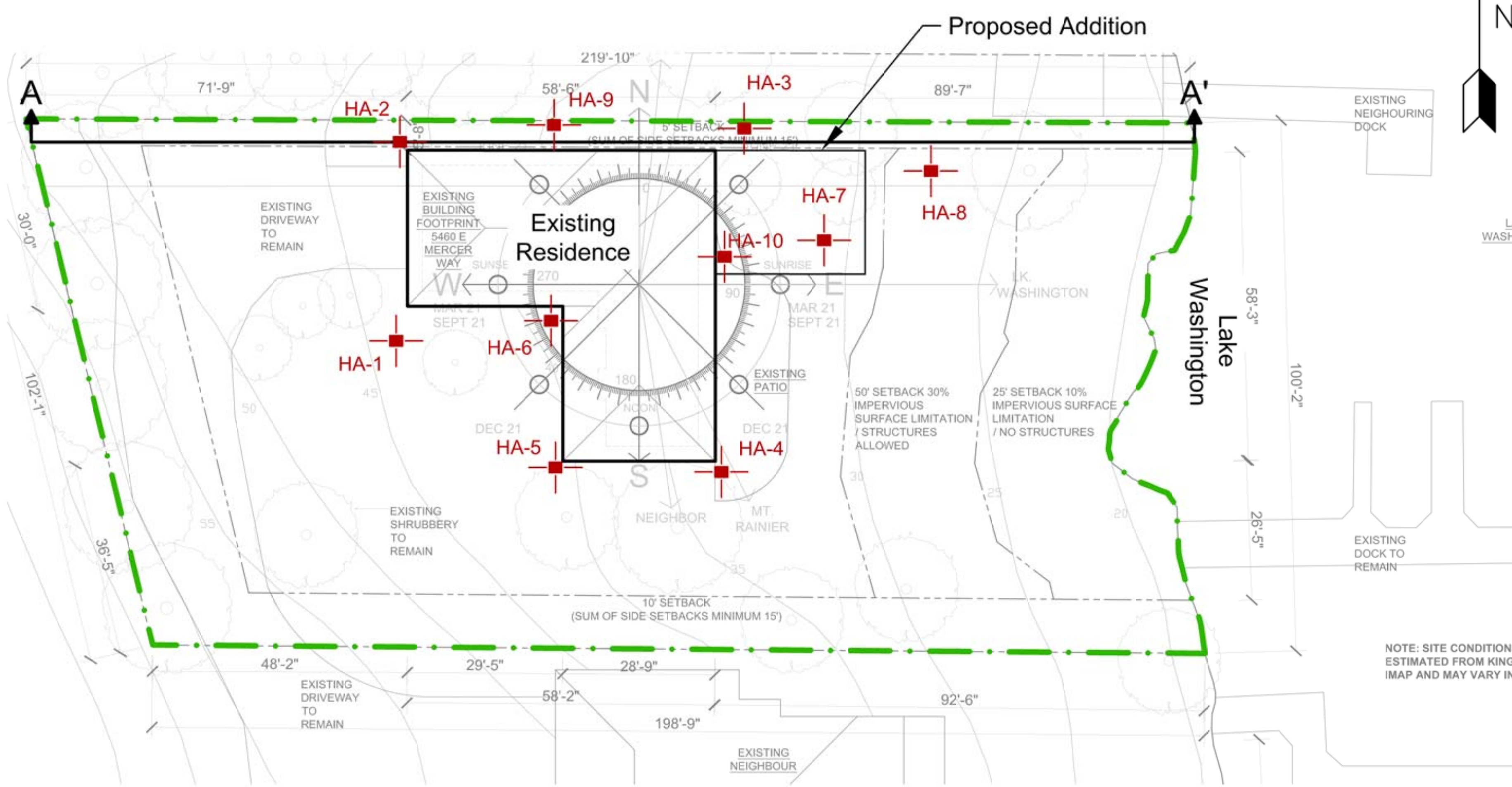
NGA

17311-135th Ave. NE, A-500
Woodinville, WA 98072
(425) 486-1669 / Fax 481-2510

Snohomish County (425) 339-1669
Wenatchee/Chelan (509) 665-7696
www.nelsongeotech.com

N:\2017 NGA Project Folders\9814-17 Bull Residence Addition Mercer\Drafting\VM.dwg

Site Plan



LEGEND

- Property line
- HA-1: Number and approximate location of hand auger
- A / A': Approximate location of cross-section

Scale: 1 inch = 30 feet (0, 30, 60)

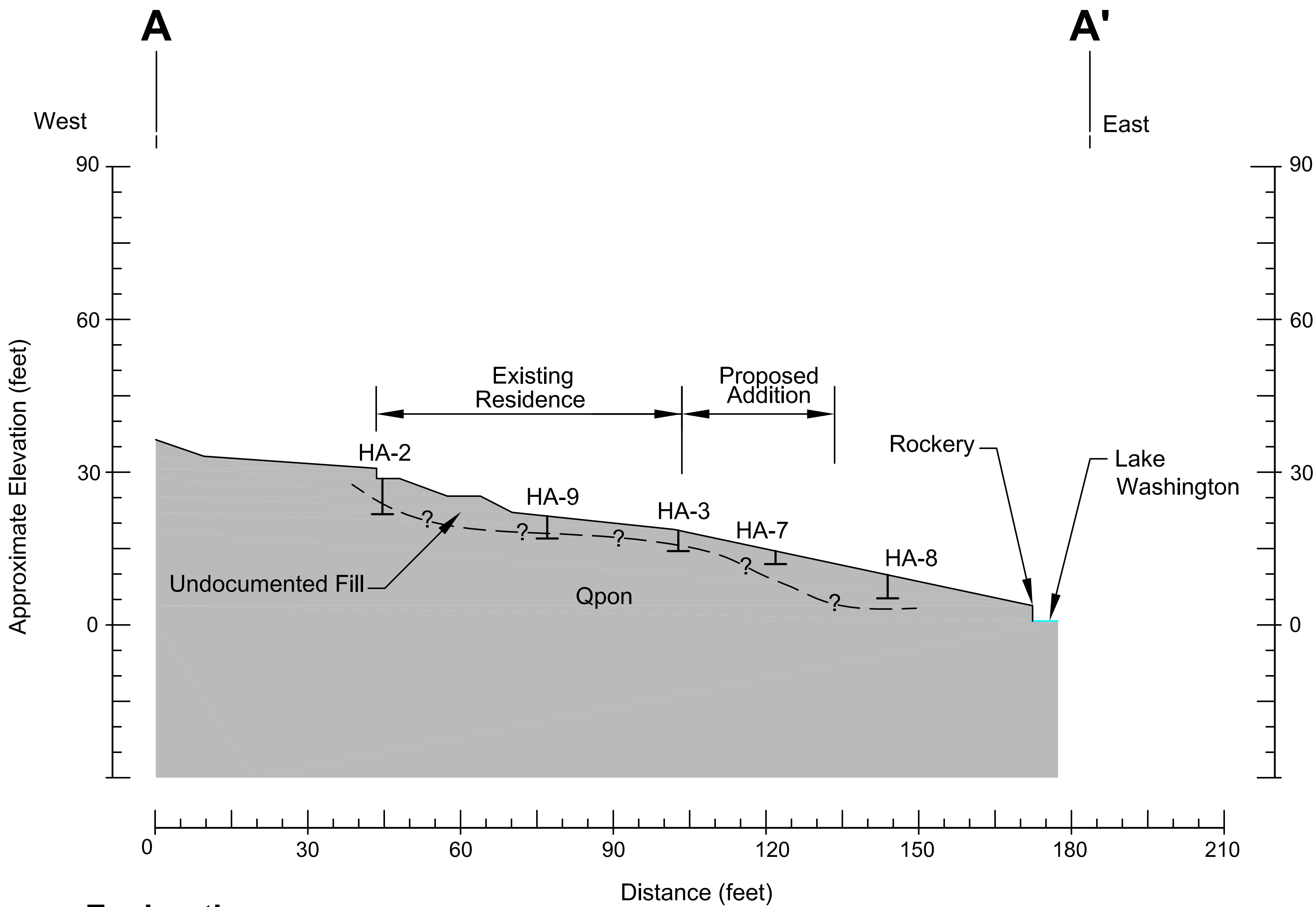
Reference: Site plan based on a plan dated January 4, 2017 titled "LS Residence," prepared by Babienko Architects, PLLC.

N:\2017 NGA Project Folders\9814-17 Bull Residence Addition Mercer\Drafting\SP.dwg

Project Number	Bull Residence Addition Site Plan	Nelson Geotechnical Associates, Inc.
981417		
Figure 2		

NGA
Nelson Geotechnical Associates, Inc.
Geotechnical Engineers & Geologists
17311-135th Ave. NE, A-500
Woodinville, WA 98072
(425) 486-1669 / Fax 481-2510
Snohomish County (425) 337-1669
Wenatchee/Chelan (509) 665-7696
www.nelsongeotech.com

No.	Date	Revision	By	CK
1	2/7/17	Original	DPN	KMS



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	Bull Residence Addition Cross-Section A-A'	Nelson Geotechnical Associates, Inc. Geotechnical Engineers & Geologists
981417		
Figure 3		

NGA
Nelson Geotechnical Associates, Inc.
Geotechnical Engineers & Geologists
17311-135th Ave. NE, A-500
Woodinville, WA 98072
(425) 486-1669 / Fax 481-2510
437 East Penny Road
Wenatchee, WA 98801
(509) 665-7696

No.	Date	Revision	By	CK
1	2/7/17	Original	DPN	KMS

N:\2017 NGA Project Folders\9814-17 Bull Residence Addition Mercer\Drafting\CS.dwg

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 981417	Bull Residence Addition Soil Classification Chart	Nelson Geotechnical Associates, Inc.	No.	Date	Revision	By	CK
Figure 4		Geotechnical Engineers & Geologists	1	2/7/17	Original	DPN	KMS

NGA
17311-135th Ave. NE, A-500
Woodinville, WA 98072
(425) 486-1669 / Fax 481-2510
Snohomish County (425) 337-1669
Wenatchee/Chelan (509) 665-7696
www.nelsongeotech.com

N:\2017 NGA Project Folders\9814-17 Bull Residence Addition Mercer\Drafting\SC.dwg

LOG OF EXPLORATION

DEPTH (FEET)	USC	SOIL DESCRIPTION
HAND AUGER 1		
0.0 – 1.3		BROWN SILTY FINE SAND WITH COBBLES AND TRACE MEDIUM SAND AND DEBRIS, INCLUDING BRICKS, 1/4-INCH PVC PIPE, AND 1/16-INCH ROOTS (LOOSE TO MEDIUM DENSE, MOIST) (**TOPSOIL**)
1.3 – 2.6		LIGHT BROWN TO RED-BROWN SILTY FINE TO MEDIUM SAND WITH TRACE FINE GRAVEL (LOOSE TO MEDIUM DENSE, MOIST) (**FILL**)
2.6 – 3.0		GRAY-BROWN PARTLY-MOSTLY OXIDIZED SILTY FINE TO MEDIUM SAND AND GRAVEL (LOOSE TO MEDIUM DENSE, MOIST) (**FILL**)
3.0 – 3.8		GRAY GRAVELLY SILTY SAND WITH CLAY AND TRACE ORGANIC DEBRIS, INCLUDING 1/16-INCH DIAMETER ROOTS (MEDIUM DENSE, WET) (**FILL**)
		SAMPLES WERE COLLECTED AT 1.0, 1.5, AND 2.5 FEET GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED CAVING WAS NOT ENCOUNTERED HAND AUGER TEST HOLE MET REFUSAL AT 3.8 FEET ON 01/31/2017
HAND AUGER 2		
0.0 – 0.3		ASPHALT
0.3 – 0.7		CONCRETE
0.7 – 1.5		LIGHT BROWN TO BROWN PARTLY OXIDIZED SILTY SAND WITH TRACE GRAVEL (LOOSE TO MEDIUM DENSE, MOIST) (**FILL**)
1.5 – 2.3		GRAY-BROWN TO BROWN FINE TO MEDIUM SAND AND SILT WITH FINE GRAVEL (LOOSE TO MEDIUM DENSE, MOIST) (**FILL**)
2.3 – 4.5		BROWN SAND WITH GRAVEL AND TRACE ORGANIC DEBRIS, INCLUDING TREE BARK (LOOSE TO MEDIUM DENSE, MOIST) (**FILL**)
4.5 – 7.0	SM	BROWN SILTY FINE TO MEDIUM SAND WITH GRAVEL (MEDIUM DENSE, WET)
		SAMPLES WERE COLLECTED AT 1.0, 1.8, AND 6.5 FEET GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 6.0 FEET CAVING WAS NOT ENCOUNTERED HAND AUGER TEST HOLE COMPLETED AT 7.0 FEET ON 01/31/2017
HAND AUGER 3		
		MOSS AND GRASS
0.0 – 0.2		BROWN SILT AND FINE SAND WITH 1/16-INCH ROOTS (MEDIUM DENSE, MOIST) (**TOPSOIL**)
0.2 – 1.5		BROWN FINE TO MEDIUM SAND WITH GRAVEL AND SILT AND TRACE ORGANIC DEBRIS, INCLUDING CONIFEROUS LITTER (MEDIUM DENSE, MOIST) (**FILL**)
1.5 – 3.0		GRAY TO BROWN PARTLY OXIDIZED SILTY SAND WITH TRACE FINE GRAVEL (MEDIUM DENSE, MOIST-WET) (**FILL**)
3.0 – 3.5		LENSES OF GRAY-BLUE CLAYEY SILT, BROWN LIGHTLY TO COMPLETELY OXIDIZED SILTY FINE TO MEDIUM SAND AND FINE GRAVEL WITH TRACE ORGANIC DEBRIS, INCLUDING ROOTS AND CHARCOAL (MEDIUM DENSE, MOIST) (**FILL**)
3.5 – 4.0	SM	LIGHT GRAY-BROWN SILTY FINE TO MEDIUM SAND WITH GRAVEL (DENSE-VERY DENSE, DRY-MOIST)
		SAMPLES WERE COLLECTED AT 3.0 AND 3.5 FEET NO GROUNDWATER SEEPAGE WAS ENCOUNTERED CAVING WAS NOT ENCOUNTERED HAND AUGER TEST HOLE MET REFUSAL AT 4.0 FEET ON 01/31/2017

LOG OF EXPLORATION

DEPTH (FEET)	USC	SOIL DESCRIPTION
HAND AUGER 4		
0.0 – 0.8		DARK BROWN SILTY FINE TO MEDIUM SAND WITH TRACE FINE GRAVEL AND ORGANIC DEBRIS, INCLUDING LEAF LITTER AND 1/16-INCH ROOTS (LOOSE-MEDIUM DENSE, MOIST) (**TOPSOIL**)
0.8 – 3.5		BROWN TO TAN GRAVELLY SILTY SAND WITH TRACE COBBLES AND ORGANIC DEBRIS, INCLUDING CHARCOAL (LOOSE TO MEDIUM DENSE, MOIST) (**FILL**) BECOMING WET AT 2.8 FEET
		SAMPLES WERE COLLECTED AT 0.75 AND 3.5 FEET GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED CAVING WAS NOT ENCOUNTERED HAND AUGER TEST HOLE MET REFUSAL AT 3.5 FEET ON 01/31/2017
HAND AUGER 5		
0.0 – 0.4		DARK BROWN SILTY FINE TO MEDIUM SAND AND TRACE ORGANIC DEBRIS, INCLUDING 1/16-INCH ROOTS (LOOSE TO MEDIUM DENSE, MOIST) (**TOPSOIL**)
0.4 – 5.8		BROWN SILTY MEDIUM TO COARSE SAND WITH GRAVEL (LOOSE TO MEDIUM DENSE, MOIST) (**FILL**) BECOMING WET AT 4.5 FEET
5.8 – 7.0		DARK BROWN SILTY FINE TO MEDIUM SAND AND GRAY SILT-CLAY (VERY STIFF/DENSE, MOIST) (**FILL**)
7.0 – 7.3		BROWN SILTY FINE TO MEDIUM SAND WITH TRACE COARSE SAND AND FINE GRAVEL (VERY DENSE, WET) (**FILL**)
		SAMPLES WERE COLLECTED AT 6.0 AND 7.25 FEET NO GROUNDWATER SEEPAGE WAS ENCOUNTERED CAVING WAS NOT ENCOUNTERED HAND AUGER TEST HOLE COMPLETED AT 7.3 FEET ON 01/31/2017
HAND AUGER 6		
0.0 – 0.6		GRAY MEDIUM TO COARSE SAND WITH 0.1-INCH BRICK (LOOSE, MOIST) (**FILL**)
0.6 – 1.0		BROWN SILTY FINE TO MEDIUM SAND WITH ANGULAR GRAVEL (MEDIUM DENSE, MOIST) (**FILL**)
1.0 – 6.0		BROWN-GRAY SILTY FINE TO MEDIUM SAND WITH TRACE FINE GRAVEL AND IRON OXIDE STAINING (MEDIUM DENSE, MOIST) (**FILL**) 0.3-INCH ORGANIC RICH LAYER ENCOUNTERED AT 4.8 FEET BECOMING WET BELOW 5.0 FEET
		NO SAMPLES WERE COLLECTED NO GROUNDWATER SEEPAGE WAS ENCOUNTERED CAVING WAS NOT ENCOUNTERED HAND AUGER TEST HOLE MET REFUSAL AT 6.0 FEET ON 01/31/2017
HAND AUGER 7		
0.0 – 0.5		BROWN SILTY SAND WITH ORGANIC DEBRIS INCLUDING 1/16-INCH ROOTS (LOOSE TO MEDIUM DENSE, MOIST) (**TOPSOIL**)
0.5 – 2.5		BROWN SILTY FINE TO MEDIUM SAND WITH GRAVEL, COBBLES AND ORGANICS (DENSE, MOIST-WET) (**FILL**)
		SAMPLE WAS COLLECTED AT 2.0 FEET NO GROUNDWATER SEEPAGE WAS ENCOUNTERED CAVING WAS NOT ENCOUNTERED HAND AUGER TEST HOLE MET REFUSAL AT 2.5 FEET ON 01/31/2017

LOG OF EXPLORATION

DEPTH (FEET)	USC	SOIL DESCRIPTION
HAND AUGER 8		
0.0 – 0.8		BROWN SILT AND SAND WITH TRACE FINE GRAVEL AND ORGANIC DEBRIS, INCLUDING 1/8-INCH ROOTS (LOOSE) (**TOPSOIL**)
0.8 – 1.0		LIGHT BROWN SILTY FINE TO MEDIUM SAND WITH TRACE GRAVEL (DENSE, MOIST) (**FILL**)
1.0 – 4.0		GRAY-BROWN PARTLY OXIDIZED SILTY FINE TO MEDIUM SAND WITH TRACE COARSE SAND AND GRAVEL AND ORGANIC DEBRIS, INCLUDING CHARCOAL (LOOSE TO MEDIUM DENSE, MOIST) (**FILL**) SUBSURFACE VOID ENCOUNTERED FROM 1.5 – 3.2 FEET
4.0 – 4.5		BROWN-DARK BROWN FINE TO MEDIUM SAND WITH TRACE SILT, FINE GRAVEL AND ORGANICS (LOOSE TO MEDIUM DENSE, MOIST-WET) (**FILL**) BECOMING WET AT 4.25 FEET
		SAMPLES WERE COLLECTED AT 0.75, 1.5, AND 4.0 FEET NO GROUNDWATER SEEPAGE WAS ENCOUNTERED CAVING WAS NOT ENCOUNTERED HAND AUGER TEST HOLE COMPLETED AT 4.5 FEET ON 01/31/2017
HAND AUGER 9		
0.0 – 0.5		DARK BROWN SILT AND SAND WITH TRACE COBBLE AND 1/16-INCH ROOTS (MEDIUM DENSE, MOIST) (**TOPSOIL**)
0.5 – 1.3		GRAY-BROWN TO TAN PARTLY TO MOSTLY OXIDIZED SILTY FINE TO MEDIUM SAND WITH TRACE GRAVEL AND ORGANICS (MEDIUM DENSE, MOIST)
1.3 – 3.0		GRAY-LIGHT BROWN PARTLY OXIDIZED SILT AND FINE SAND WITH TRACE FINE GRAVEL AND ORGANICS (VERY STIFF, MOIST)
3.0 – 4.0	SM	GRAY SILTY FINE SAND (MEDIUM DENSE, MOIST)
4.0 – 4.2	SM	GRAY SILTY FINE SAND WITH GRAVEL (MEDIUM DENSE TO DENSE, MOIST TO WET)
		SAMPLES WERE COLLECTED AT 0.5, 1.25, 3.0, AND 3.8 FEET GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 4.0 FEET CAVING WAS NOT ENCOUNTERED HAND AUGER TEST HOLE MET REFUSAL AT 4.2 FEET ON 01/31/2017
HAND AUGER 10		
0.0– 6.0		DARK BROWN SILTY FINE TO MEDIUM SAND WITH GRAVEL, COBBLES AND ORGANICS (LOOSE, MOIST-WET) **(FILL)** TOP OF RESIDENCE FOUNDATION ENCOUNTERED AT APPROXIMATELY 6.0 FEET BELOW THE GROUND SURFACE
		SAMPLE WERE NOT COLLECTED NO GROUNDWATER SEEPAGE WAS ENCOUNTERED CAVING WAS NOT ENCOUNTERED HAND AUGER TEST HOLE WAS COMPLETED AT 6.0 FEET ON 01/31/2017