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March 7, 2024

Ms. Sisi Duan
3H Development, LLC
Via Email: sisi@nexgengo.com

Geotechnical Engineering Evaluation
3H Development, LLC 72nd Avenue SE Residence Development
2419 – 72nd Avenue SE
Mercer Island, Washington
NGA File No. 1502724

Dear Ms. Duan:

We are pleased to submit the attached report titled *"**Geotechnical Engineering Evaluation – 3H Development, LLC 72nd Avenue SE Residence Development – 2419 - 72nd Avenue SE – Mercer Island, Washington.**"* This report summarizes our observations of the existing surface and subsurface conditions within the property and provides general recommendations for the proposed site development. Our services were completed in general accordance with the proposal signed by you on February 14, 2024.

The property is currently occupied by a single-family residence within the southwestern portion of the property. The ground surface within the property slopes gently down from southwestern corner of the property to the northeastern corner of the property. We understand that the proposed development will include removal of the existing site structures and construction of a new single-family residence within the central portion of the property.

We monitored the excavation of four trackhoe excavated test pits, one was utilized for infiltration testing on February 19, 2024. Our explorations indicated that the site was generally underlain by surficial topsoil with competent, native glacial till soils at 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. In general, the native glacial till soils underlying the site should adequately support the planned structure. For bearing capacity and settlement considerations, foundations should be advanced through the loose and/or undocumented fill soils and be supported directly on the competent glacial material interpreted to underlie the site, or structural fill extending to these soils. These soils should generally be encountered approximately 2.0 to 3.0 feet below the existing ground surface, based on our explorations. However, deeper areas of loose soil and/or undocumented fill could also exist within unexplored areas of the site. If undocumented fill is encountered in unexplored areas of the site, it should be removed and replaced with structural fill for foundation and pavement support.

Final stormwater plans have also not been developed, but we understand that on-site infiltration is being considered for this site. The subsurface soils generally consisted of surficial topsoil/undocumented fill soils underlain by silty, fine to medium sand with gravel and silt with sand in a stiff to very hard condition, that we interpreted as native glacial till soils. We attempted to conduct a small-scale PIT within the property per the 2019 Stormwater Management Manual for Western Washington (2019 SWMMWW). However, after we had filled the excavation with 12-inches of water for the pre-soak period and the water was shut off, the water level in the excavation increased a few inches due to the presence of groundwater seepage. As a result, the test was terminated. Due to the presence of groundwater and relatively fine-grained compact nature of the native glacial till soil encountered throughout the site in our explorations, it is our opinion that stormwater infiltration within the site is not feasible. We recommend that the stormwater generated from the proposed development be directed to either on-site dispersion systems or on-site detention systems and ultimately directed towards an approved point of discharge, likely found within the neighboring roadways.

In the attached report, we have included recommendations for general site grading, foundation and slab support, retaining walls, erosion control, and drainage. We recommend that Nelson Geotechnical Associates (NGA) be retained to review the geotechnical aspects of the project 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 during the construction 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

This report presents the results of our geotechnical engineering investigation and evaluation of the planned 3H Development, LLC 72nd Avenue SE Residence Development project located at **2419 – 72nd Avenue SE in Mercer Island, Washington** as shown on the Vicinity Map in Figure 1. The purpose of this study is to explore and characterize the site's surface and subsurface conditions and to provide geotechnical recommendations for the planned site development.

The property is currently occupied by a single-family residence within the southwestern portion of the property. The ground surface within the property slopes gently down from southwestern corner of the property to the northeastern corner of the property. We understand that the proposed development will include removal of the existing site structures and construction of a new single-family residence within the central portion of the property. Specific grading plans had not been developed at the time we prepared this report. The existing site layout is shown on the Site Plan in Figure 2.

SCOPE

The purpose of this study is to explore and characterize the site surface and subsurface conditions and provide general recommendations for site development.

Specifically, our scope of services includes the following:

1. Reviewing available soil and geologic maps of the area as well as other relevant geotechnical information, as provided.
2. Exploring the subsurface soil and conditions within the site using trackhoe-excavated test pits. Excavation services were provided by NGA.
3. Providing long-term design infiltration rates based on on-site Small Pilot Infiltration Testing (PIT) per the 2019 SWMMWW, if feasible.
4. Performing laboratory grain-size sieve analysis on soil samples, as necessary.
5. Providing recommendations for earthwork and foundation support.
6. Providing recommendations for temporary and/or permanent shoring, as needed.
7. Providing recommendations for temporary and permanent slopes.

8. Providing recommendations for subsurface utilities and pavement subgrade preparation.

9. Providing our opinion on stormwater infiltration feasibility.

10. Providing general recommendations for site drainage and erosion control.

11. Documenting the results of our findings, conclusions, and recommendations in a written geotechnical report.

SITE CONDITIONS

Surface Conditions

The subject site consists of a rectangular-shaped parcel covering approximately 0.21 acres. The site is currently occupied by a single-family residence within the southwestern portion of the property. The ground surface within the property slopes gently down from southwestern corner of the property to the northeastern corner of the property. Vegetation within the site consists of yard areas, landscaping plants and young to mature trees. The site is bordered to the east by 72nd Avenue SE and by neighboring residential properties on all other sides. We did not observe surface water throughout the site during our field work on February 19, 2024.

Subsurface Conditions

Geology: The geologic units for this area are shown on the map titled, Geologic Map of Mercer Island, Washington, by Troost, K.G. and Wisher, A.P. (GeoMapNW, 2006). The site is mapped as Vashon advance outwash (Qva) with Vashon subglacial till (Qvt) mapped nearby. Vashon advance outwash is described as well-sorted sand and gravel deposited by streams and is overlain by the Vashon Till. Vashon subglacial till is generally described as a compact mixture of silt, sand, and gravel. In our explorations, we generally encountered silty, fine to medium sand with gravel and silt with sand, consistent with the description of Vashon subglacial till at depth.

Explorations: The subsurface conditions within the site were explored on February 19, 2024, by monitoring the excavation of four test pits to depths ranging from 4.0 to 8.0 feet below the existing ground surface using a mini-trackhoe. The approximate locations of our explorations are shown on the Site Plan in Figure 2. A geologist from NGA was present during the explorations, examined the soils and geologic conditions encountered, obtained samples of the different soil types, and maintained logs of the explorations. The soils were visually classified in general accordance with the Unified Soil Classification System, presented in Figure 3. The logs of our explorations are attached to this report and are presented as Figure 4. We present a brief summary of the subsurface conditions in the following paragraph. For a detailed description of the subsurface conditions, the exploration logs should be reviewed.

At the surface of all of our explorations, we generally encountered 0.5 to 2.0 feet of loose dark brown silty fine to medium sand with gravel, organics and debris that we interpreted as surficial topsoil. Underlying the surficial topsoil in each of our explorations, we encountered stiff to very hard, brown-gray to gray, silt with varying amounts of fine sand and gravel which we interpreted as native glacial till soils. All of our explorations were terminated within the native glacial till soils at depths in the range of 4.0 to 8.0 feet below the existing ground surface.

Hydrogeologic Conditions

Light groundwater seepage was encountered in Test Pits One and Three at depths in the range of 2.5 to 3.5 feet below the existing ground surface. We interpreted this groundwater seepage to be perched groundwater. Perched water occurs when surface water infiltrates through less dense, more permeable soils and accumulates on top of a relatively low permeability material. Perched water does not represent a regional groundwater "table" within the upper soil horizons. Perched water tends to vary spatially and is dependent upon the amount of rainfall. We would expect the amount of perched groundwater to decrease during drier times of the year and increase during wetter periods.

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	1.393	0.485	1.000	null	0.929	null

The spectral response accelerations were obtained from the OSHPD Seismic Design Maps website 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 till 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 this area of Mercer Island as Kitsap silt loam, 2 to 8 percent slopes. This material is listed as having a moderate erosion hazard. Based on our observations and the material encountered, we would interpret this site as having a low to moderate 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.

CONCLUSIONS AND RECOMMENDATIONS

General

It is our opinion that the planned residence development within the site is feasible from a geotechnical standpoint. Our explorations indicated that the site was underlain by surficial topsoil with stiff to very hard native glacial till soils at depth. These glacial soils should provide adequate support for foundation, slab, and pavement loads. We recommend that the structures be designed utilizing shallow foundations. Footings should extend through any loose surficial soil and be keyed into the underlying competent native glacial bearing soils. These soils should be encountered roughly 2.0 to 3.0 feet below the ground surface based on our explorations. We should note that localized areas of deeper unsuitable soils and/or undocumented fill could be encountered at this site. This condition would require additional excavations in foundation, slab, and pavement areas to remove the unsuitable soils.

Depending on the overall site grading, tall cuts may be needed to facilitate the construction of the proposed structure. These cuts may not be able to be safely sloped back due to site constraints such as neighboring property lines and utilities. If temporary cuts are not able to be safely sloped as recommended in this report, we recommend that the cuts be shored with either a temporary Ultra Block wall or a soldier pile retaining wall. If a soldier pile retaining wall is utilized, this wall could be designed as a permanent wall and incorporated into the building. We provided recommendations for temporary and permanent cut slopes in the **Temporary and Permanent Slopes** section of this report. We also provide recommendations for the temporary Ultra Block and soldier pile shoring walls in the **Temporary Ultra Block Shoring Wall** and **Soldier Pile Shoring Wall** subsections of this report.

Based on the results of our on-site infiltration testing and soil explorations throughout the site, it is our opinion that the onsite native glacial till soils are not conducive for traditional stormwater infiltration methods. This is further discussed in the **Site Drainage** section of this report.

The soils encountered on this site are considered moisture-sensitive and will disturb easily when wet. 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, 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.

Erosion Control Measures

The erosion hazard for the on-site soils is considered to be low to moderate but the actual hazard will be dependent on how the site is graded and how water is allowed to concentrate. Best Management Practices (BMPs) should be used to control erosion. Areas disturbed during construction should be protected from erosion. Erosion control measures may include diverting surface water away from the stripped or disturbed areas. Silt fences and/or straw bales should be erected to prevent muddy water from leaving the site. Stockpiles should be covered with plastic sheeting during wet weather. 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 to moderate.

Site Preparation and Grading

After erosion control measures are implemented, site preparation should consist of stripping any loose soils and/or undocumented fill to expose medium dense or better native glacial soil in foundation, slab-on-grade, and pavement areas. The stripped materials should be removed from the site or stockpiled for later use as landscaping fill. Based on our observations, we anticipate stripping depths of 2.0 to 3.0 feet within the proposed development area. However, additional stripping may be required if areas of deeper undocumented fill and/or loose soil are encountered in unexplored areas of 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 and failures on the slopes, as well as result in inadequate subgrades. NGA should be retained to evaluate the suitability of all on-site and imported structural fill material during construction.

Temporary and Permanent Slopes

Temporary cut slope stability is a function of many factors, including the type and consistency of soils, depth of the cut, surcharge loads adjacent to the excavation, length of time a cut remains open, and the presence of surface 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 at all times as indicated in OSHA guidelines for 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 upper surficial and/or undocumented fill soils be no steeper than 1.5 Horizontal to 1 Vertical (1.5H:1V). Temporary cuts in the competent native glacial soils at depth should be no steeper than 1H:1V. We recommend that temporary cut slope excavations be performed as to not disturb the 1H:1V inclination extending down from the base of the neighboring residence or retaining wall foundations to the bottom of the temporary cuts. If temporary cut excavations are not able to achieve the recommended inclinations, we recommend that the cuts be temporarily shored with either an Ultra Block shoring wall or a soldier pile shoring wall as discussed in the **Temporary Ultra Block Shoring Wall and Soldier Pile Shoring Wall** subsections of this report, respectively.

Any temporary cut excavations to be located within a 1H:1V inclination from the neighboring foundations should be supported entirely with a soldier pile shoring wall. If a soldier pile shoring wall is utilized to support temporary excavations within this property, we recommend that the soldier piles be installed in drilled shafts filled with concrete due to the relatively dense, compact nature of the native glacial till soils encountered at depth. Due to the soil conditions, we would anticipate that installation of the beams via driven impact methods may prove difficult and adequate embedment depths may not be achieved.

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. 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 vegetated, and the vegetative cover maintained until established.

Due to the likely close proximity of the planned temporary excavations and shoring systems to the neighboring properties and structures, we recommend that settlement monitoring survey points be installed on the surrounding structures during construction and monitored at least once a week until it is confirmed that no movement is occurring. We should be retained to discuss wall and surrounding structure monitoring plans as project plans are finalized. Additional photographic and visual pre-existing surveys of the project vicinity and neighboring structures prior to construction activities should also be performed to document existing conditions within the vicinity of the property.

Temporary Shoring Walls

General: Specific grading plans were not available at the time this report was prepared. However, we anticipate that tall cuts and retaining walls will likely be needed for the planned structures depending on the final grades. Due to the proposed depth of the anticipated cuts and tight site constraints from existing properties, we anticipate that temporary/permanent shoring walls may be needed to support the cut excavations for structure construction.

Temporary Ultra Block Shoring Wall: If temporary cut excavations as recommended above cannot be accommodated because of close proximity of the excavations to the property-lines, we recommend that the cuts be temporarily shored with an Ultra Block shoring wall. The total height of the shoring wall should not exceed 7.5 feet. The Ultra Block wall should be constructed with a vertical batter or a slight lean back towards the cut and should be supported directly on competent native bearing glacial till soils. All vertical joints between blocks should be staggered at each row. Temporary cuts above the temporary Ultra Block shoring wall should be sloped back away from the wall at 1.5H:1V or flatter inclination and should be no greater than four feet in overall height. All exposed soils above the shoring wall should be protected from erosion. The Ultra Block wall is considered only a temporary excavation support measure and should be buried or removed, and permanent support established by the building retaining walls. A Schematic Wall Detail is shown on Figure 5.

The Ultra Block wall materials should be readily available on site prior to beginning excavation of the temporary cuts to be shored. The cut should be sloped or benched as needed for temporary stability, and wall construction should be accomplished immediately after excavation of the temporary slopes. Safe worker access should be maintained at all times during wall construction. We recommend that the construction of the new Ultra Block wall be performed in short segments no greater than 15 feet in length and be entirely completed using machinery. No personnel should be present between the wall and the cut at any time. Gaps between the wall and cuts should be backfilled with clean 1¼-inch crushed rock. Even with all of these precautions, some sloughing of the excavations may still occur. We therefore recommend that neighboring property owners be notified of such potential if cuts are planned on or near property lines.

Soldier Pile Shoring Wall

General: A soldier pile shoring wall could also be utilized to support cut excavations around the proposed structures. A soldier pile wall typically consists of a series of steel H-beams placed vertically at a certain spacing between H-beams (typically six to ten feet). The beams are usually placed in drilled shafts that are filled with structural concrete or a lean mix. The concrete shafts are typically embedded below the bottom of the planned excavation a distance equal to one to two times the exposed height of the wall. The steel beams are extended above finished ground surface to provide shoring capabilities for the area to be retained. The beams are typically spanned by pressure treated timber lagging or concrete panels. The H-beam size, shaft diameter, shaft embedment, and pile spacing are dependent on the nature of the soils anticipated to be retained by the wall and the soils at depth, wall height, drainage conditions, and the final geometry. A schematic detail of the wall is shown on the Soldier Pile Wall Detail in Figure 6.

Wall Design: The shoring wall should be designed by an experienced structural engineer licensed in the State of Washington. The lateral earth pressure acting on the shoring wall will be dependent on the nature and density of the soil behind the wall, structure and traffic loads on the wall, and the amount of lateral wall movement that may occur as material is excavated from the front of the wall. If the shoring wall is free to yield at least one-thousandth of the retained height, an "active" loading condition develops. If the wall is restrained from movement by stiffness or bracing, the wall is considered in an "at-rest" loading condition. Active and at-rest earth pressure can be calculated based on equivalent fluid densities. The shoring wall should be designed to resist a lateral load resulting from a fluid with a unit weight of 40 and 60 pounds per cubic foot (pcf) for the active and at-rest loading conditions, respectively. An additional uniform surcharge of 8H should be applied to the wall design to account for seismic loading, if the shoring walls are intended to provide permanent support; **H** in this case, is the exposed height of the wall. These loads should be applied across the pile spacing above the excavation line. These loads can be resisted by a passive pressure of 200 pcf on the below grade very stiff or better soils encountered at depth. The passive pressure should be applied on two-pile diameters under the excavation line. These values of the passive pressure incorporate a factor of safety of 2.0. The upper two feet of pile embedment should be neglected when calculating the passive resistance for the permanent condition.

Also, for the permanent condition, the below-grade portion of the wall should be no less than 1.5 times the wall stick-up height. The above loads should be applied on the full center-to-center pile spacing above the base of the exposed portion of the wall. A 50 percent reduction of the active pressure could be applied for the purpose of designing the wall lagging. The above pressures assume that the on-site soils retained by the shoring wall are not significantly disturbed and that hydrostatic forces are not allowed to build up behind the wall. These values do not include the effects of surcharges other than what is described above.

The retained soils should be readily drained and collected water should be routed into a permanent storm system. Adequate gaps should be maintained between the lagging elements to allow for any potential water seepage buildup to flow through the wall. The wall designer should calculate the predicted wall deflection, including deflection resulting from the below-grade movement of the piles. The predicted deflection values should be confirmed in the field through a survey monitoring program. Also, surrounding structures should be monitored for any adverse effects resulting from shoring wall installation.

Shoring Wall Installation: The shoring wall should be installed by a shoring contractor experienced with this type of system. We anticipate that an open-hole drilling method may be feasible for installing the soldier piles in the on-site soils but recommend that the shoring contractor have the capability of casing the holes as sloughing and/or water seepage may be encountered. It might be prudent to perform one or more "test" holes to confirm installation conditions prior to finalizing budget and work plans. Any sloughing or water that may collect in the drilled holes should be removed prior to pumping grout. Grout should be readily available on site at the time the holes are drilled. If groundwater seepage is encountered, we recommend that water be pumped out of the holes and the concrete be tremied from the bottom of the excavations to displace the groundwater to the surface. Extra Portland Cement, or other additives, may also be placed in the excavations to reduce the effects of seepage. The spoils from the soldier pile excavations are expected to be moisture-sensitive materials and should be removed from the site. We should be retained to monitor on-site activities during the shoring wall installation on a full-time basis.

Foundations

Conventional shallow spread foundations should be placed on undisturbed medium dense or better native glacial till soils. Medium dense or better native glacial bearing soils should be encountered roughly 2.0 to 3.0 feet below the ground surface based on our explorations; however, deeper areas of loose soil and/or undocumented fill may be encountered in unexplored areas of the site. Where undocumented fill or less dense soils are encountered at footing bearing elevation, the subgrade should be over-excavated to expose suitable bearing soil. 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 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 2,500 pounds per square foot (psf) be used for the design of footings founded on the medium dense or better native soils or structural fill extending to the competent native 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 1-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.

Structural Fill

General: Fill placed beneath foundations, 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 prior to beginning fill placement. Sloping areas to receive fill should be benched using a minimum 8-foot-wide horizontal benches keyed into competent soils.

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 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 more granular on-site soils may be suitable for use as structural fill, but this will be highly dependent on the moisture content of these soils at the time of construction. We should be retained to evaluate all 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 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.

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 may be used to protect the vapor barrier membrane and to aid in curing the concrete.

Pavements

Pavement subgrade preparation and structural filling where required, should be completed as recommended in the **Site Preparation and Grading** and **Structural Fill** subsections of this report. The pavement subgrade should be proof-rolled with a heavy, rubber-tired piece of equipment, to identify soft or yielding areas that require repair. The pavement section should be underlain by a minimum of six inches of clean granular pit run or crushed rock. We should be retained to observe the proof-rolling and recommend repairs prior to placement of the asphalt or hard surfaces.

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 in the upper five feet of the backfill within the roadway and should be tested. Trenches located in non-structural areas and five feet below roadway subgrade should be compacted to a minimum 90% of the maximum dry density.

Site Drainage

Infiltration: The subsurface soils generally consisted of compact silty sand with gravel that we interpreted as native glacial till deposits to the depths explored. The 2019 SWMMWW was utilized to determine the appropriate sizing of the proposed on-site infiltration systems. We conducted one Small PIT within Infiltration Test Pit One, as shown on the attached Site Plan in Figure 2.

Infiltration Test Pit One measured 4.0-feet long by 3.0-feet wide by 4.0-feet deep. Infiltration Test Pit One was filled with approximately 12-inches of water and this level was maintained for six hours for the pre-soak period. At the end of the pre-soak period, the water level rose approximately 0.75-inches without adding any additional water. As a result, the infiltration testing was concluded.

Based on the results of the small-PIT, presence of perched groundwater seepage encountered within some of the explorations, and the relatively silty compact nature of the native glacial till soils that underlie the site, it is our opinion that the onsite native glacial till soils are not conducive for stormwater infiltration systems. We recommend that the stormwater generated from the proposed development be directed to on-site dispersion systems or on-site detention systems and ultimately directed towards an approved point of discharge, likely found within the neighboring roadways. Stormwater systems should be developed by the project civil engineer.

Surface Drainage: Final site grades should allow for drainage away from the planned residence area. 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 structure. Runoff generated on this site should be collected and routed into a permanent discharge system. This should include all downspouts and runoff generated on all hard surfaces and yards areas. Under no circumstances should water be allowed to flow uncontrolled over the site. Water should not be allowed to collect in any area where footings or slabs are to be constructed.

Subsurface Drainage: If groundwater is encountered during construction, we recommend that the contractor slope the bottom of the excavation and collect the water into ditches and small sump pits where the water can be pumped out of the excavation and routed into a suitable outlet. We recommend that the residence down spouts and footing drains be tightlined to an appropriate discharge location. We recommend the use of footing drains around structures. Footing drains should be installed at least one foot below planned finished floor elevation. The drains should consist of a minimum 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 should extend up the wall to one foot below the finished surface. The top foot of soil should consist of low permeability soil placed over plastic sheeting or building paper to minimize the migration of surface water or silt into the footing drain. Footing drains should discharge into tightlines leading to an appropriate collection and discharge point with convenient cleanouts to prolong the useful life of the drains. Roof drains should not be connected to wall or footing drains.

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.

USE OF THIS REPORT

NGA has prepared this report for **Ms. Sisi Duan** and associated agents, for use in the planning and design of the development 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.

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 during the work differ from those anticipated, and to evaluate whether or not earthwork and foundation installation activities comply with contract plans and specifications. We should be contacted a minimum of one week prior to construction activities and could attend pre-construction meetings if requested.

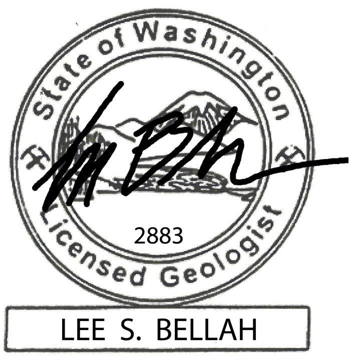
Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering practices in effect in this area at the time this report was prepared. No other warranty, expressed or implied, is made. Our observations, findings, and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

o-o-o

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

Sincerely,

NELSON GEOTECHNICAL ASSOCIATES, INC.



Lee S. Bellah, LG
Senior Geologist

3.07.2024

Khaled M. Shawish, PE
Principal

FKS:LSB:KMS:dy

Six Figures Attached

VICINITY MAP

Not to Scale

N

Mercer Island, WA

Project Number	3H Development, LLC	NELSON GEOTECHNICAL ASSOCIATES, INC	No.	Date	Revision	By	CK
1502724	72nd Avenue SE		1	2/28/24	Original	AMS	LSB
Figure 1	Residence Development Vicinity Map						

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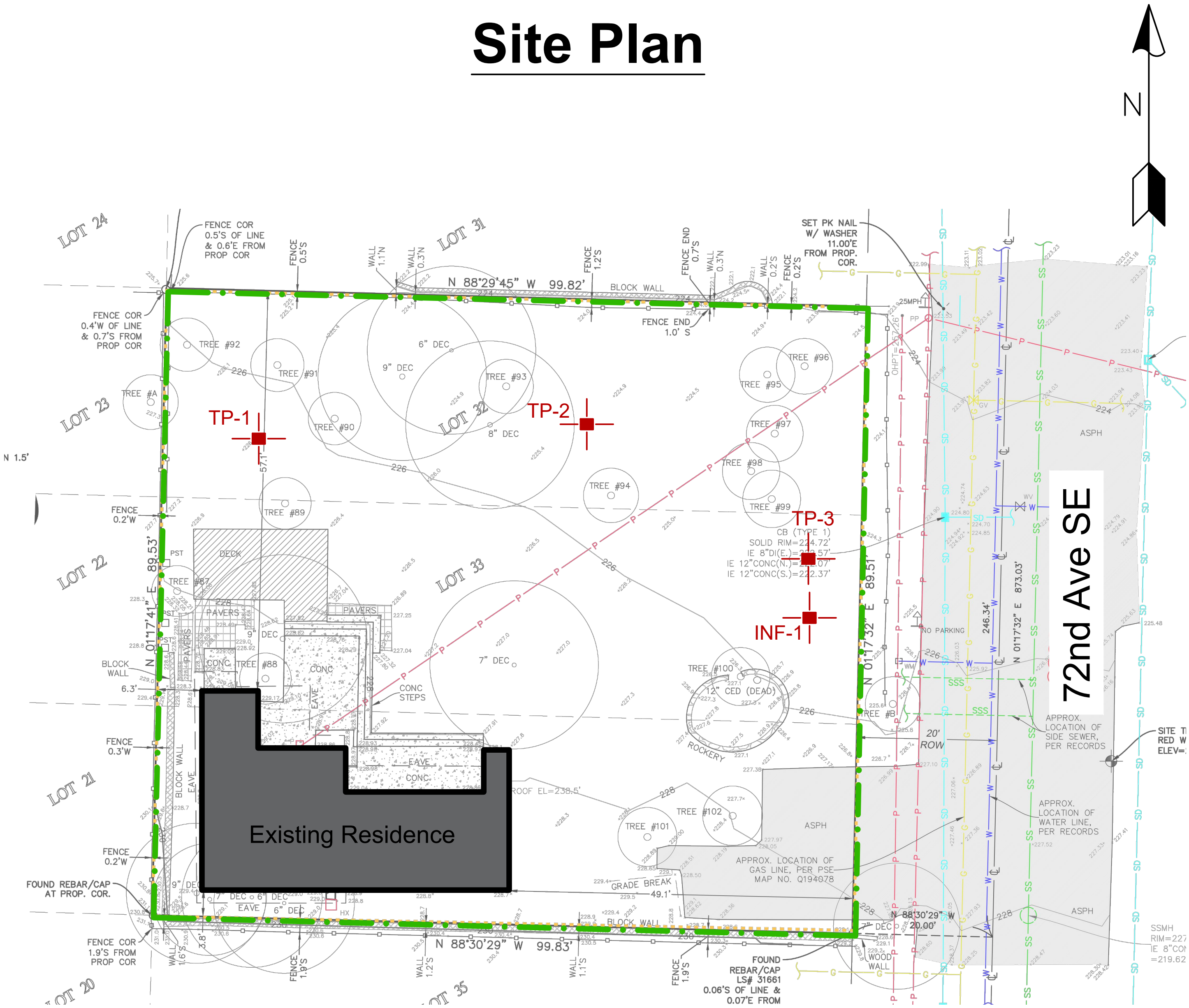
Site Plan



LEGEND

Property line

TP-1 — Number and approximate location of test pit

INF-1 — Number and approximate location of infiltration pit

0 20 40

Approximate Scale: 1 inch = 20 feet

Reference: Site Plan based on field measurements, observations, and aerial parcel map review.

Project Number	3H Development, LLC	NELSON GEOTECHNICAL ASSOCIATES, INC	No.	Date	Revision	By	CK
1502724	72nd Avenue SE		1	2/28/24	Original	AMS	LSB
Figure 2	Residence Development Site Plan						

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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 1502724	3H Development, LLC 72nd Avenue SE Residence Development Soil Classification Chart
Figure 3	

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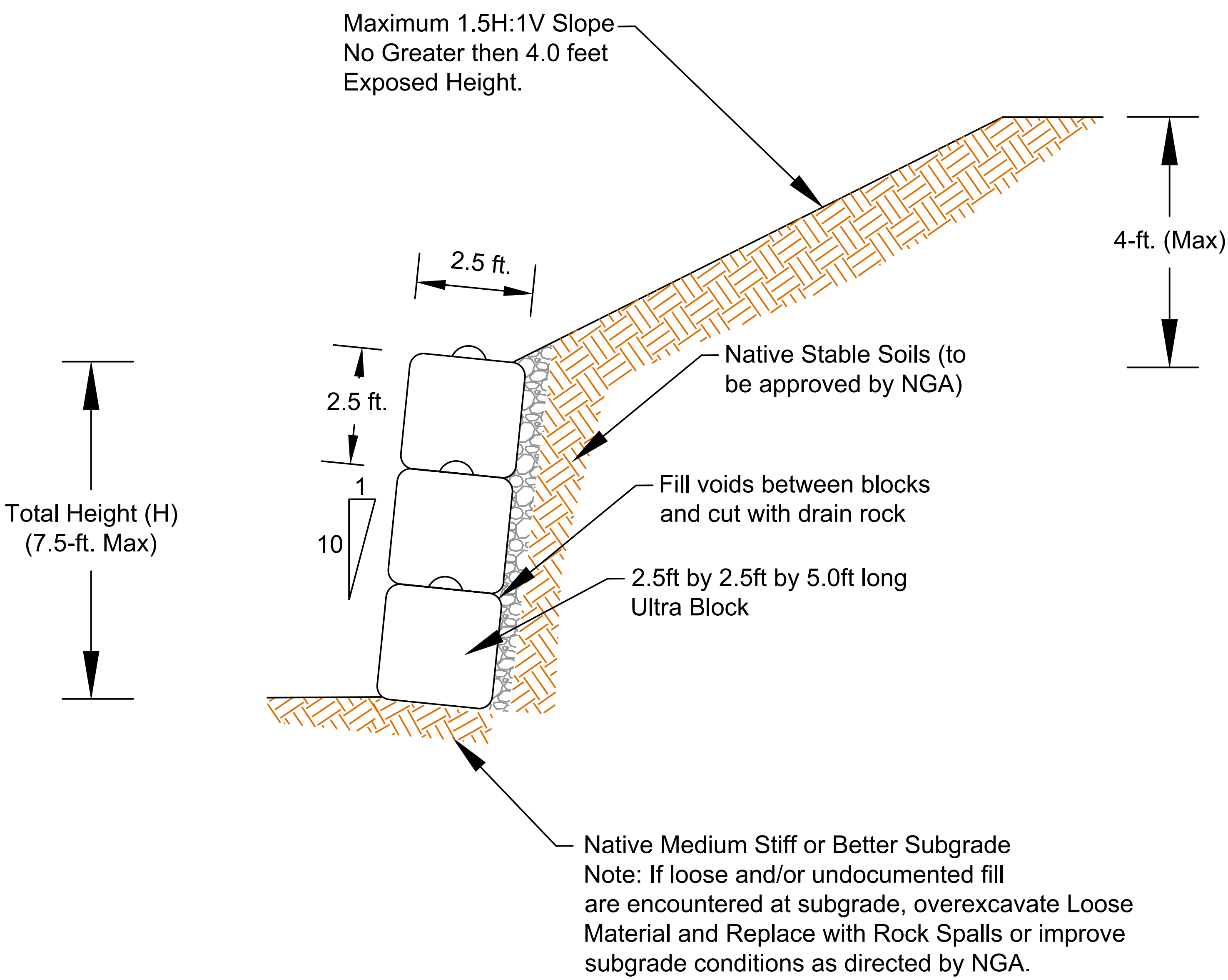
No.	Date	Revision	By	CK
1	2/28/24	Original	AMS	LSB

LOG OF EXPLORATION

DEPTH (FEET)	USCS	SOIL DESCRIPTION
TEST PIT TP-1		
0.0 – 0.5		**TOPSOIL**
0.5 – 3.0	ML	BROWN-GREY, SANDY SILT WITH GRAVEL, IRON OXIDE STAINING (STIFF TO VERY STIFF, MOIST TO WET)
3.0 – 8.0	ML	GREY, SILT WITH TRACE GRAVEL, IRON OXIDE STAINING (HARD TO VERY HARD, MOIST TO WET)
		SAMPLES WERE COLLECTED AT 3.5 AND 6.0 FEET LIGHT GROUNDWATER SEEPAGE WAS ENCOUNTERED FROM 2.5 TO 3.5 FEET NO TEST PIT CAVING WAS ENCOUNTERED TEST PIT WAS COMPLETED AT 8.0 FEET ON 2/19/24
TEST PIT TP-2		
0.0 – 1.0		**TOPSOIL**
1.0 – 3.0	ML	BROWN-GREY, SANDY SILT WITH TRACE GRAVEL, IRON OXIDE STAINING (STIFF TO VERY STIFF, MOIST TO WET)
3.0 – 8.0	ML	GREY, SILT WITH SAND AND TRACE GRAVEL (HARD TO VERY HARD, MOIST)
		SAMPLES WERE COLLECTED AT 3.5 AND 7.0 FEET NO GROUNDWATER SEEPAGE WAS ENCOUNTERED NO TEST PIT CAVING WAS ENCOUNTERED TEST PIT WAS COMPLETED AT 8.0 FEET ON 2/19/24
TEST PIT TP-3		
0.0 – 2.0		**TOPSOIL**
2.0 – 3.0	SM	BROWN-GREY, SILTY FINE TO MEDIUM SAND WITH GRAVEL (MEDIUM DENSE, MOIST TO WET)
3.0 – 8.0	ML	GREY, SILT WITH SAND AND TRACE GRAVEL (HARD TO VERY HARD, MOIST TO WET)
		SAMPLES WERE COLLECTED AT 3.0 FEET LIGHT GROUNDWATER SEEPAGE WAS ENCOUNTERED FROM 2.5 TO 3.0 FEET NO TEST PIT CAVING WAS ENCOUNTERED TEST PIT WAS COMPLETED AT 8.0 FEET ON 2/19/24
INF TEST PIT INF-1		
0.0 – 1.0		GRASS/**TOPSOIL**
1.0 – 3.0	ML	BROWN-GREY, SANDY SILT (STIFF TO VERY STIFF, MOIST TO WET)
3.0 – 4.0	ML	GREY, SILT WITH SAND AND TRACE GRAVEL (HARD TO VERY HARD, MOIST)
		NO SAMPLES WERE COLLECTED NO GROUNDWATER SEEPAGE WAS ENCOUNTERED NO TEST PIT CAVING WAS ENCOUNTERED TEST PIT WAS COMPLETED AT 4.0 FEET ON 2/19/24

Temporary Ultra Block Shoring Wall Detail

(Not to Scale)



Project Number 1502724	3H Development, LLC 72nd Avenue SE Residence Development Temporary Ultra Block Shoring Wall Detail	NELSON GEOTECHNICAL ASSOCIATES, INC	No.	Date	Revision	By	CK
Figure 5			1	3/5/24	Original	ABT	LSB

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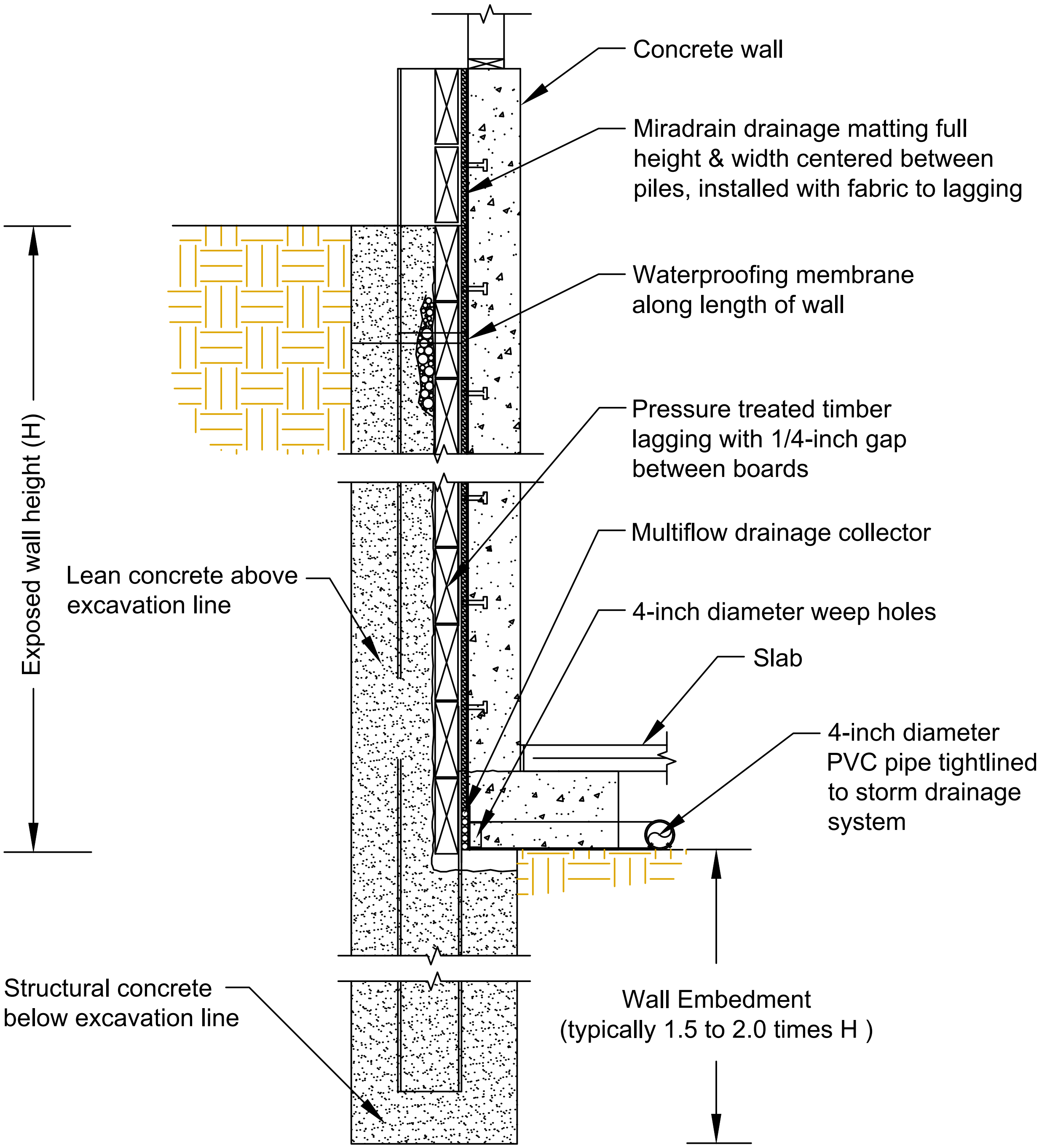
Conceptual Soldier Pile Wall Detail

NOT FOR CONSTRUCTION USE



NOT TO SCALE

Project Number 1502724	3H Development, LLC 72nd Avenue SE Residence Development Soldier Pile Wall Detail	NELSON GEOTECHNICAL ASSOCIATES, INC	No.	Date	Revision	By	CK
Figure 6		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	3/5/24	Original	ABT	LSB

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