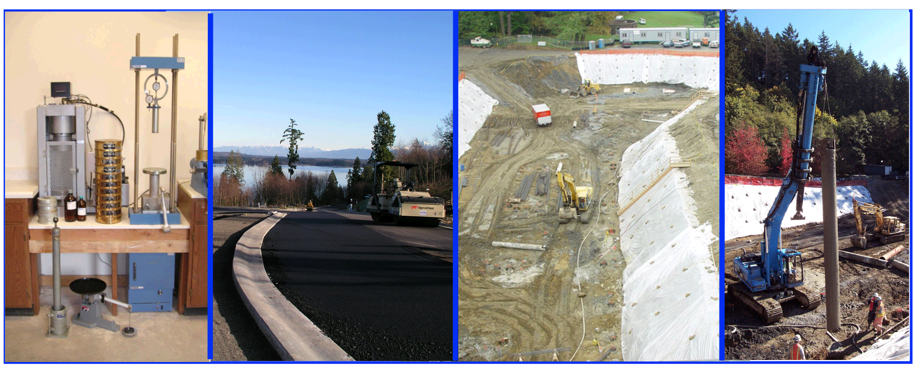
MERIT ENGINEERING INC.

# GEOTECHNICAL ENGINEERING INVESTIGATION

Proposed Single Family House
5425 96th Ave SE
Mercer Island, Washington
Parcel#: 1438700145



Prepared For:
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5425 96th Ave SE
Mercer Island, Washington

August 8, 2022
Project No. 2DF0422984

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Bin Zhang
c/o Mei Yang
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Re: Geotechnical Engineering Investigation
5425 96th Ave SE
Mercer Island, WA
Parcel#:1438700145

Dear Zhang Bin:

At your request, we have conducted a geotechnical engineering investigation at the above referenced project site. The following geotechnical engineering report represents the results of our visual site reconnaissance, DCP test observations, engineering analysis, and derived conclusions on the slope stability of proposed residential buildings.

Thank you for this opportunity to work with you on this project. Please contact us if you have any questions about this report.

Sincerely,

Austin X. Huang, Ph.D., P.E., L.G., D.GE., F.ASCE
Principal

*F.ASCE: Fellow - American Society of Civil Engineering*
*D.GE - Diplomate - Academy of GeoProfessionals*

*D.GEs provide successful projects that benefit their clients.*
*The D.GE certification recognizes geotechnical engineers who possess specialty education, extensive experience, integrity, and good judgment.*

# GEOTECHNICAL ENGINEERING REPORT

Proposed Single Family House
5425 96th Ave SE
Mercer Island, Washington

Prepared for:

Bin Zhang
5425 96th Ave SE
Mercer Island, Washington

by


August 8, 2022

Austin X. Huang, Ph.D., P.E., L.G., G.DE, F.ASCE
Principal

August 8, 2022
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# TABLE OF CONTENTS

**LETTER OF TRANSMITTAL** ........ i

**SIGNATURES PAGE** ........ ii

**TABLE OF CONTENTS** ........ iii

**1. INTRODUCTION** ........ 1

**2. PROJECT DESCRIPTION** ........ 2

**3. SCOPE** ........ 2

**4. SITE INVESTIGATION** ........ 3

*4.1 Surface Conditions* ........ 3

*4.2 Subsurface Conditions* ........ 4

*4.3 Geologic Background* ........ 5

*4.4 Surface and Groundwater Conditions* ........ 6

**5. GEOLOGIC HAZARDS** ........ 6

**6. CRITICAL AREA EVALUATION** ........ 9

**7. SLOPE STABILITY EVALUATION** ........ 11

**8. CONCLUSIONS AND RECOMMENDATIONS** ........ 15

*8.1 Site Preparation and Grading* ........ 16

*8.2 Cut and Fill* ........ 17

*8.3 Construction Recommendations* ........ 19

*8.4 Structural Fill* ........ 20

*8.5 Foundation Design Parameters* ........ 21

*8.6 Foundation Drainage* ........ 22

*8.7 Slab-On-Grade Floor* ........ 23

*8.8 Lateral Earth Pressure* ........ 23

*8.9 Seismic Design Parameters* ........ 25

**9. GEOLOGIC HAZARD MITIGATION** ........ 27

**10. GENERAL CONDITIONS** ........ 30

**APPENDIX** ........ 33

*Figure 1* ........ Location & Vicinity Map

*Figure 2* ........................................................................................................................ Site Plan
*Figure 3* ............................................................................................................ Soil Classification
*Figures 4 -6* ……………………………………..………………..……..DCT Tests
*Figures 7 -8* …………………………………..……..STABLE Computer Model Results
*Figures 9 -10* ……………………………………………………Property Cross Sections

# 1. INTRODUCTION

At request of Bin Zhang, Merit Engineering, Inc. has conducted a geotechnical engineering investigation for the proposed development of the site, located at immediate west of 5425 96th Ave SE, in Mercer Island, Washington 98040 (Parcel #1438700145). The project area and vicinity is shown in Figure 1 and the site plan with proposed new single family house and test locations in Figure 2 in the Appendix.

We understand, from the information you provided to us, that the proposed project is to construct a new residential single family house on the vacant lot. We understand that the proposed house will be at the toe of the slope. The house will be built against the slope with the footing for the upper level on the lower portion of the slope. Based on the topographic map provided by CHADWICK and WINTERS LAND SURVEYING and MAPPING, the slope at north portion of the subject property is approximately 1.4H:1V (~70%), greater than 40%, which falls in Geologically Steep Slope Hazardous Area concern according to the City of Mercer Island Land Development Code (LDC).

Therefore, the objective of this study specifically was to investigate surface, subsurface, and slope conditions at the site, conduct a hazard analysis, derive conclusions, and provide recommendations for site preparation, design, construction and geologic hazard mitigation of the proposed house. The report will, in particular, address critical area concerns of geologically hazardous area, to comply with City of Mercer Island Land Development Code 19.07.060 - Critical area maps and inventories, 19.07.090 - Critical area reviews, 19.07.100 - Mitigation sequencing, 19.07.110 - Critical area study, and 19.07.160 - Geologically hazardous.

## 2. PROJECT DESCRIPTION

The project site is a rectangular-shaped parcel of land with an area of approximately 21,665sf. The site is at the end of SE 54th St and surrounded by single-family houses to east, south, and north. Topography at property has generally two portions. The upper portion has a steep slope approximately 1.4H:1V (~70%) with local elevation loss ~14ft, roughly 35° following up with approximately 2H:1V (~51%) slope with local elevation loss ~9ft, roughly 27°. The lower portion has a gentle slope approximately 5.1H:1V (~20%) to the 96th Ave SE at east and ultimately reaches to the Lake of Washington.

The proposed house will be at the toe of the 2H:1V (~51%) steep slope. The house will be built against the steep slope at the lower portion of the steep slope.

## 3. SCOPE

Based on all the above information and understanding of the project and difficult access, we conducted a site exploration using Dynamic Cone Penetration Test (DCP[1]) with scope of work in compliance with our proposal No. P2BL0232711 dated June 13, 2022, in particular includes:

- Conducting a site reconnaissance of the property and adjacent area;
- Conducting three (3) DCP to maximum depth of 7.6 feet, where penetration refusal was encountered.
- Logging soil and ground water conditions;
- Performing a slope stability analysis;
- Performing engineering analysis;
- Preparing a geotechnical engineering report with geotechnical engineering recommendations:
    - (1) surface conditions;
    - (2) subsurface soil conditions;
    - (3) groundwater conditions, and

[1] DCP test consists of driving a 10 $cm^2$ (1.4″ diameter) cone into the ground. The cone is attached to steel rods and driven by a 35 pound hammer with 15″ free fall. Number of blows for each 10 cm (4″) penetration was recorded

(4) computer model analysis of slope stability

**Recommendations for:**

(5) foundation design parameters,
(6) structural fill and compaction criteria,
(7) foundation retaining wall design parameters,
(8) slab-on-grade floor,
(9) drainage,
(10) site grading, and

# 4. SITE INVESTIGATION

## *4.1 Surface Conditions*

The project site is a rectangular-shaped parcel of land. This subject site is located at hillside at east of E Mercer Way overlooking east to Lake Washington. Site reconnaissance was performed by a representative of Merit Engineering, Inc. on June 29, 2022 during our field DCP tests. The project site lies within a single parcel located at south of SE 54th St in Mercer Island, Washington. A survey completed by CHADWICK and WINTERS LAND SURVEYING and MAPPING was used in this study to construct site plans showing property lines, major features, and test locations (Figures 2). The City of Mercer Island, King county online GIS map program was used to reference general topographic features at the site. Detailed slope measurements taken by Merit Engineering, Inc. were then used to note the topographic contours and location of steep slope to better reflect actual site conditions and create a topographic profile (Figure 9) for slope interpretation, discussed later in this report. DCP tests were performed by a representative on June 29, 2022. We also observed surface topography, surface soils, vegetation, and surface water conditions at the subject slope.

The site is situated approximately halfway down the southeast flank of hill at east of E Mercer Way. The top of the hill is at an elevation ~160´ with an east slope down to the lake. The rectangular-shaped parcel slopes from northwest to southeast with 21,665 square feet area. The north boundary of site is at an elevation of ~101ft with a southeast slope of 12° ( ~21.4%) over an average horizontal distance 14ft with elevation loss ~3ft down to the top of steep slope at an elevation ~98ft.

Further to southeast at an elevation of approximately 98ft is the top of the steep slope. This steep slope has two portions. The upper portion slope angle is 35° (~70%) over an average horizontal distance 20ft with elevation loss of ~14ft. The lower portion slope is approximate 27° (~51%) over an average horizontal distance 17.6ft with elevation loss of ~9ft. Upper level of the proposed house will be supported by footings on lower portion of steep slope. Site topography is dominated by the steep slope with a total local elevation loss of ~23ft over a horizontal distance ~37.6ft.

The steep slope continues with a gentle slope approximately 5.1H:1V (~20%) to the 96th Ave SE at east and ultimately reaches to the Lake of Washington.

Vegetation on the steep slope is characterized by ground cover including shrubs and ferns. We have not observed incline and movement of trees in the proposed parcel.

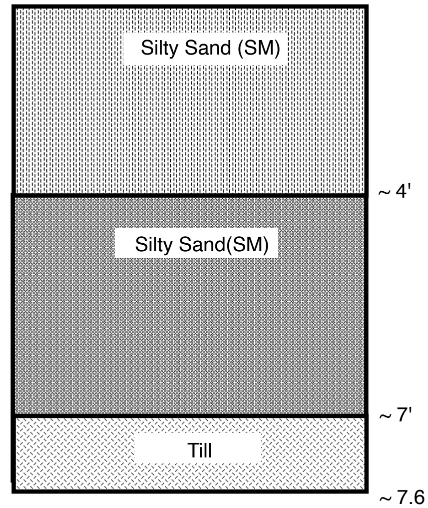
### 4.2 Subsurface Conditions

Subsurface soil and ground water conditions were investigated by conducting three (3) DCP tests to maximum 7.6´ depth on June 29, 2022. Test locations are shown on the site plan (Figure 2). Test logs are presented in the Appendix of this report as Figures 4 through 6. Descriptions of soil symbols and classifications used in this report are also presented in the Appendix (Figure 3). Site soils are generalized in the schematic and summarized as follows:

a. Silty Sand (SM)

b. Silty Sand with gravel (SM)

c. Silty Fine Sand with gravel (Till)




**a. Silty Sand (SM)**

A layer of loose silty which varies in thickness from 0" - 4' generally blankets the slope. The more closer to the top of slope, the shallower of this loose silty sand is. The soil was damp, crumbly when disturbed, and loose in situ.

**b. Silty Sand (SM)**

A layer of silty sand underlying the topsoil extends to the depth of ~7´. The soil is medium dense to dense.

**c. Silty Fine Sand with gravel (Till)**

Underlying the silty sand beginning at ~7' depth to the total penetration depth of ~7.6´ was a layer of silty sand with gravel and pebbles. The sand was very dense.

### *4.3 Geologic Background*

The Lake Washington basin and Puget Sound areas were overidden by Vashon glacier around 17,600 years Cal B.P. At its maximum extent, the ice was over 3,000 feet thick in the seattle area and extended from the foothills of the Olympics to the foothills of the Cascade Mountains and from Brithsh Columbia, Canada, to south of Olympia, Washington (Booth and others, 2004). During glacial advance, sub-glacial melt water carved the Lake Washington basin and all the troughs of Puget Sound, including the Duwamish, Green, Puyallup, and Sammamish river valleys. Sub-glacially, these troughs were connected to Puget Sound, and when the ice receded, the troughs were still connected via water.

The site is mapped as pleistocene continental glacial drift according to the 1:500,000 Washington Interactive Geological Map. The soils are described as Qgd - Pleistocene continental glacial drift, which is pleistocene till and outwash clay, silt, sand, gravel, cobbles, and boulders deposited by or originating from continental glaciers; locally includes peat, nonglacial sediments, modified land, and artificial fill. This is consistent with our exploration.

### 4.4 Surface and Ground Water Conditions

No surface water was observed and no groundwater seepage was encountered during our site exploration on June 29, 2022. However, runoff or seeps of stormwater, and possibly pockets of temporary shallow groundwater, may occur locally during periods of heavy rainfall.

## 5. GEOLOGIC HAZARDS

### 5.1 Geologic Hazard Designation and Typing

Geologic hazard areas are designated by the City of Mercer Land Development Code (LDC19.07.160A) that geologically hazardous areas are lands that are susceptible to erosion, landslides, seismic events, or other factors as identified by Washington Administrative Code (WAC 365-190-120). We researched available publications for geologic hazard areas on or in the vicinity of the site.

### 5.2 Landslide Hazards (WAC 365-190-120(6), LDC 19.07.060)

The WAC 365-190-120(6) defines Landslide Hazard Areas based on a combination of geologic, topographic, and hydrologic factors. They include any areas susceptible to landslide because of any combination of bedrock, soil, slope (gradient), slope aspect, structure, hydrology, or other factors, and include, at a minimum, the following:

(a) Areas of historic failures, such as:

(i) Those areas delineated by the United States Department of Agriculture Natural Resources Conservation Service as having a significant limitation for building site development;

(ii) Those coastal areas mapped as class u (unstable), uos (unstable old slides), and urs (unstable recent slides) in the department of ecology Washington coastal atlas; or

(iii) Areas designated as quaternary slumps, earthflows, mudflows, lahars, or landslides on maps published by the United States Geological Survey or Washington department of natural resources.

(b) Areas with all three of the following characteristics:

(i) Slopes steeper than fifteen percent;

(ii) Hillsides intersecting geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock; and

(iii) Springs or groundwater seepage.

(c) Areas that have shown movement during the holocene epoch (from ten thousand years ago to the present) or which are underlain or covered by mass wastage debris of this epoch;

(d) Slopes that are parallel or subparallel to planes of weakness (such as bedding planes, joint systems, and fault planes) in subsurface materials;

(e) Slopes having gradients steeper than eighty percent subject to rockfall during seismic shaking;

(f) Areas potentially unstable as a result of rapid stream incision, stream bank erosion, and undercutting by wave action, including stream channel migration zones;

(g) Areas that show evidence of, or are at risk from snow avalanches;

(h) Areas located in a canyon or on an active alluvial fan, presently or potentially subject to inundation by debris flows or catastrophic flooding; and

(i) Any area with a slope of forty percent or steeper and with a vertical relief of ten or more feet except areas composed of bedrock. A slope is delineated by establishing its toe and top and measured by averaging the inclination over at least ten feet of vertical relief.

We compared the each criterion of the Critical Area Ordinance with site existing conditions. Base on our investigation and engineering analysis, the site may be considered as Landslide Hazard Area as meeting criterion (i) above. The steep slope of the subject property varies between approximately 1.4H:1V(~70%) to 2H:1V (~51%), meeting the Landslide Hazard Area definition with gradient in excess of 40% (or 22°) and vertical relief of over 10´. In addition, the subject site was depicted as landslide hazards area and portion of site depicted as steep slope on City of Mercer Island GIS Map.

### *5.3 Erosion Hazard Areas (WAC 365-190-120(5), LDC 19.07.060)*

The WAC 365-190-120(5) defines erosion hazard areas include areas likely to become unstable, such as bluffs, steep slopes, and areas with unconsolidated soils. Erosion hazard areas may also include coastal erosion areas: This information can be found in the Washington state coastal atlas available from the department of ecology. Counties and cities may consult with the United States Department of Agriculture Natural Resources Conservation Service for data to help identify erosion hazard areas.

A portion of the site could meet the definition of an erosion hazard area because it has steep slopes. It also may exist during construction from disturbed soils. In addition, the subject site was depicted as erosion hazards area on City of Mercer Island GIS Map. Therefore we have included recommendations to mitigate erosion hazards at the site later in this report.

### *5.4 Seismic Hazard Areas (WAC 365-190-120(7))*

The WAC 365-190-120(7) defines seismic hazard areas must include areas subject to severe risk of damage as a result of earthquake induced ground shaking, slope failure, settlement or subsidence, soil liquefaction, surface faulting, or tsunamis. Settlement and soil liquefaction conditions occur in areas underlain by cohesionless soils of low density, typically in association with a shallow groundwater table. One indicator of potential for future earthquake damage is a record of earthquake damage in the past. Ground shaking is the primary cause of earthquake damage in Washington, and ground settlement may occur with shaking.

The site and vicinity is mapped as having a low liquefaction susceptibility to seismic shaking according to the King County Liquefaction hazard map (May, 2010). And based on our field tests, the site soils consist primarily of very dense till soil at shallow depth. See the seismic hazard discussion in section 8.3 below for more details.

## 6. CRITICAL AREAS EVALUATION

### *6.1 Slope Considerations*

During this study, we considered local slope conditions and focused on the specific slope area north of the proposed residence in order to evaluate the critical areas identified above and assess project feasibility. Cross-section profile (Figure 9) was constructed through locations of interest based on survey data and subsurface testing.

From site DCP tests, reconnaissance, and our knowledge of local geology, local slope stability on the site appears to be controlled by the relationship of the silty sand cover soil and hard refusal soil underneath.

Slope stability against erosion and local slumping is influenced by the interaction of the natural topography, shallow soil character, groundwater, and slope of the hardpan till or glacial deposits that may act as a failure plane. Cover soil stability must also be considered in relation to slope grading and design for the proposed development.

We understands that the proposed development is to build a single family house with driveway and associated utilities. At the time of preparing this report, detailed site grading and building plans were not available. According to the Topographic Survey Plan prepared by CHADWICK and WINTERS LAND SURVEYING and MAPPING, we expect that a significant amount of site grading on steep slope will be needed to reach the final finish grade elevation. After construction, the slope cut will be supported by the building wall that also function as retaining wall.

### *6.2 Hazard Analysis: Interpretations of Slope Stability*

Our site reconnaissance did not find obvious visual evidence of current or past slope stability issues within the project area. We are not aware of any historic slope failures in the site vicinity. Due to the variable nature of the geology and topography in the area, the potential for such failures can vary widely between adjacent sites, and thus should be evaluated on a site-specific basis.

Surficial soils on the site slopes may exhibit some minor surface creep or erosional instability if disturbed during construction, and may be more at risk for ongoing erosion without stabilization measures such as replanting. In general, the site does not seem to be problematic in terms of large-scale mass wasting because of the moderate dense to dense soil conditions. However, care must be taken in site design and construction to avoid loading shallow soils on slopes with fill application, walls, or other landscape features that could instigate a shallow failure of the cover soil. Recommendations on practices for slope grading and construction with erosion and drainage control are provided later in this report.

We conducted an analysis on slope stability of the slope with proposed single family house, and soil parameters estimated based on the soil type from filed tests, published soil/geological information, and publication of slope stability charts by Hoek and Bray "Rock Slope Engineering", in which they publicized computer model generated circular failure mode slope stability charts for uniform soil conditions and ground water surface at 4 times slope height behind the toe of the slope. The results show in Figure 7 and Figure 8. Using these data, our analysis indicates that the slope projected from top to the toe of slope, which is 1.4H:1V (~70%) to 2H:1V (~51%) , has a factor of safety over 1.5, which is the factor of safety we need for a permanent slope.

## 7. SLOPE STABILITY EVALUATION

We have performed a slope stability assessment using computer model analysis for factor of safety incorporating multiple methods for parameter evaluations including reconnaissance, subsurface testing, and regional interpretation. Visual reconnaissance with observations and surface mapping of slope conditions was completed during our filed test site visit.

Slope stability conditions were evaluated by using a STABLE computer model as well as by using calculations derived from literature. Soil parameters were based on field tests, soil classification, and literature values. Our model used site-specific soil parameters to determine slope conditions that have an acceptable FS (factor of safety) for static and seismic conditions.

### *7.1 Engineering Properties of Soils*

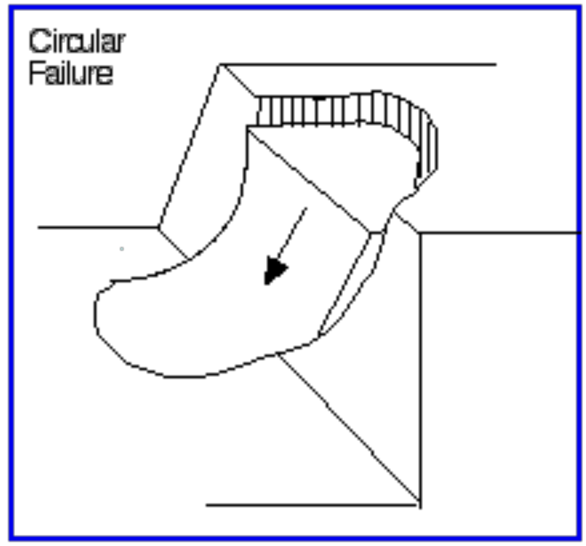
We used values for soil unit weights ($\gamma$) based on soil classification and literature values from Hoek and Bray (1981). The values for friction angles ($\phi$) of the slope soil was estimated using the correlation between $\phi$ and N (DCP test from geotechnical penetrating tests). The value for cohesion (c) of the soil was estimated using the correlation between c and N (DCP Test) and verified by similar values provided by Hoek and Bray (1981).

Hoek and Bray (1981) specify the friction angle of loose sand, mix grained size to be 34° to 40°. For pure sand cohesion to be 0 psf. Friction angle for glacial till (mixed grain size) to be 32° to 35° and the cohesion to be 3,000 psf to 5,000 psf. Our analysis is considered somewhat conservative due to selecting the lower bound parameters of estimated literature soil strength properties. Our analysis, therefore, should produce more practical results because we have verified parameters through multiple sources.

TABLE 1: Basic Engineering Properties for the Materials on Site

| Soil | Depth (ft) | | | Cohesion (psf) | Friction Angle$\phi$ | Dry Unit Wt. $\gamma$ dry, (pcf) | Sat. a Wt. $\gamma$ wet, (pcf) |
|---|---|---|---|---|---|---|---|
| | TB-1 | TB-2 | TB-3 | | | | |
| Silty Sand (SM) | 0'-3' | 0'-4' | | 0 | 32° | 99 | 124 |
| Silty Sand W/ gravel (SM) | 3'-5' | 4'-7' | 0'-6" | 0 | 32° | 109 | 130 |
| Till | 5'-5.6' | 7'-7.6' | 6"-1.3' | 3000 | 34° | 130 | 145 |

### *7.2 Slope Failure Mode*




The possible mode of slope failure at this site has to be considered for the slope stability analysis. Modes of slope failure are best categorized according to controlling geological structures. For instance, such structures can be bedrock, faults, or high strength soil layers interbedded with low strength layers. As discussed above, for this analysis we are considering the failure of the sand unit itself. Therefore, there is no significant controlling structure and the material is assumed as homogeneous soil with the internal parameters listed in Table 1. Soil slope failures are characterized to fail in a circular mode according to Hoek and Bray (1981). This will be the assumed failure mode for this site, depicted here.

### *7.3 STABLE Computer Model*

Theoretically, a slope is acceptable if the Factor of Safety (FS) is greater than 1.0. However, in practical scenarios an FS of greater than 1.0 is always adopted to account for uncertainties that may arise from either parameter estimations or approximations of conditions imposed by the analytical model which may not be perfectly applicable to the project site. A minimum FS of 1.5 is suggested for critical slopes adjacent to haul roads or important installations that are required to remain stable for long periods of time under static conditions (Hoek and Bray, 1981) and is widely adopted in civil engineering practice.

In our analysis of the subject slope, we employed the Bishop model of slices which yields more accurate results at this site over the Janbu method. Based on the parameters described in the previous sections, the STABLE program outputs a cross-section showing the ten most critical theoretical failure planes of the cross-section and the corresponding FS values for each surface. We approached the analysis in a somewhat conservative fashion, meaning the engineering properties of the soils were more indicative of the weaker soil conditions observed on the site.

To calibrate the STABLE model, one cross-sections were created using topographic information (using survey map provided to us by Terrane), shown in Appendix. We modeled groundwater begin to flow at the surface, which is 4 times H (height of slope) horizontal distance away from toe of slope. The groundwater path was modeled conservatively by this assumption due to the lack of water table encountered when performing DCP tests. We considered seismic loading conditions of the subject slope by employing a horizontal earthquake coefficient of 0.73g based on ASCE 7 Hazard Tool with ASCE/SEI 7-22 reference document for an earthquake magnitude of 6.5, typical of a near crustal event in northwest Washington. This value is selected since earthquake coefficient of 0.73g is typical for glacial dense soils based on available literature. Typically, minimum FS values employed for seismic conditions are ~75% of target static value (FS ~ 1.125).

### *7.4 Discussion of Results*

**Slope Stability**

Results of analysis incorporating the full-scale slope condition are shown in Figure 7 and Figure 8. For curves originating past the base of the slope and extending to the top of slope, Factor of Safety values are well above target values. Recorded static values are FS = 3.85;

seismic values are FS =2.54. The high FS values despite the slope size are attributed to the presence of the resistance upper soil unit of hardpan glacial deposits.

**Slope Stability With Proposed House**

According to the preliminary building plan, the proposed building will occupy between elevation 69´ and 81´ with footing at lower portion steep slope between elevation 75´ and 81´. Based on the topographic map, the height of the steep slope is approximately 26´. Using these data, our analysis indicate that the steep slope projected from top to toe, which has slope from 1.4H:1V (~70%) to 2H:1V (~51%), has a factor of safety over 1.5, which is the factor of safety we need for a permanent slope.

Based on our derived soil properties and site parameters, shown on the Table 1 for the entire slope from top to the toe, the ten (10) most critical surfaces were created, shown in Figure 8. The factor of safety for the critical surfaces range from 3.85 to 5.93, which is over 1.5 for representative cross-section A-A'. This gives us that in the proposed slope with proposed house may be satisfactory.

Analysis showed that cross-sections A-A', Figure 9, do meet the minimum FS of 1.125 for seismic conditions for a horizontal earthquake coefficient of 0.73g.

## 8. CONCLUSIONS AND RECOMMENDATIONS

We have conducted a study of existing site and slope conditions and slope stability assessment for the proposed single family house at immediate west of 5425 96th Ave SE, in Mercer Island, Washington 98040 (Parcel #1438700145) to fulfill City of Mercer Island critical area requirements. The results of our site testing and reconnaissance are presented herein with accompanying discussion on slope stability concerns and interpretations.

We conclude, and it is our opinion based on the results and stated limitations of this study, that the site is suitable for the proposed single family house if recommendations in this report are followed. The proposed alterations to the Critical Area should not decrease slope stability on the subject or adjacent properties, adversely impact the surrounding Critical Areas, or increase surface water discharge, sedimentation, or erosion rates if the recommendations in this report are followed.

The following sections present a summary of this study and our recommendations for construction of single family house to erosion control, stormwater control, and drainage control to enhance and protect slope stability as possible within the subject property.

We understand the project location is designated as a geologically critical area. Therefore, it is our understanding that the analyses and recommendations provided in this report are based on the assumption that our firm's level of professional services will be retained for future project design and construction phase services as needed. We recommend that we be contacted to review final plans for development after the recommendations of this report are considered, to ensure they are consistent with the results and intent of recommendations herein.

### *8.1 Site Preparation and Grading*

We recommend removing any organic topsoils and unsuitable loose and soft soils from the areas under the proposed residential structure. We anticipate that soil excavation can be accomplished with conventional equipment, although excavation into the hardpan till may be more difficult.

Any soft subgrade soils encountered during site excavation should be removed and replaced with structural fill as recommended in the Structural Fill section of this report. Based on our observations, the native silty sand subsoil may be suitable for subgrade depending on fine content, organic content, and moisture levels. If the subsoil is present at proposed subgrade level, it should be evaluated in the field, and its suitability may depend on the specific structure be installed at a given location.

Dry season construction at this site is recommended. Due to the sloping nature of the site, we recommend that care be taken to the maximum extent possible for erosion and ground control. It should be understood that significant additional costs and construction difficulty could be incurred if work proceeds in wet weather comparing with dry weather construction. Therefore, we don't recommend wet season construction.

We recommend that we observe and verify site excavation to suitable subgrade soils, test to verify import fill materials, and observe and test compaction of structural fill materials.

### *8.2 Cut and Fill*

We have identified two main geotechnical scenarios for the proposed site development including a combination of 1) excavation cut to grade, and 2) spot filling to grade. We generally recommend that the building foundation be constructed in a "cut" scenario. Meaning that the foundation is placed on intact native soil set into the slope profile rather than outward onto the slope. This method typically is more stable in the long-term, while filling on slope sides often leads to subsidence or shallow failures over time from loading the cover soil. Our recommendations for areas of fill are intended for use to even out the final grades locally, and should be avoided if possible, especially on the steeper portions of the slope. We generally recommend that construction of the foundation be completed by cutting into the uphill portion of the slope, we do not recommend grade filling.

**Cut Excavation**

A cut in grade is preferred for construction of any foundations or structural features. Based on the test results, loose soils exist down to a depth of ~5´ in the building pad area. We recommend a cut in grade level that entails full removal of the unsuitable and loose soil down to the underlying firm native soil or hardpan. Subgrade should be cut in a series of steps so that prepared surfaces are flat and horizontal. Footings or slabs should be placed directly on firm native soils or hardpan till, or on compacted structural fill over firm native soils. The amount of cut grading may be limited by native firm soil or glacial till, where refusal is encountered in the building pad area. We recommend cutting into the slope to the maximum depth possible without costly and time consuming removal of the dense soils. Depending on final house design, there may be a daylight basement with a foundation wall that supports a soil cut bank. This wall also need to be engineered as retaining wall.

**Fill Grading**

As stated above, filling should only be used as necessary to help with local grading, and should be avoided in steeper areas of the slope and under foundations. We recommend the top organic soil and unsuitable loose or soft subsoils be removed prior to applying any fill, to ensure a stable, unyielding base. Grade fill should be structural quality, meeting the requirements in the Structural Fill section of this report. On-site soils may be suitable for general landscaping or grade fill, however we recommend that we evaluate and verify the condition of the material prior to installing, which may be weather dependent. If on-site material is used it should still be capped with 6˝ - 8˝ of compacted structural fill for the base section.

We recommend that we be contacted to observe fill activities, verify subgrade, and test compaction of import material.

### 8.3 Construction Recommendations

#### 8.3.1 Temporary Excavations

Temporary soil cutslopes during earthwork without control measures should generally be no steeper than 2:1 (Horizontal:Vertical) for sandy soil, and should be evaluated for general stability after shaping and periodically in construction. For temporary cutslopes that will remain exposed for any length of time, we recommend that we review conditions on site. We also recommend that we review and consult on the proposed methods of excavation prior to earthwork, and that we verify excavation to suitable cutbank conditions and geometry during construction. As local variations may exist between locations within the site, we recommend that we evaluate all cutbanks to ensure they are consistent with the conclusions in this report, and if necessary provide alternate recommendations per location.

Maximum temporary excavation depths are expected to extend to depth of 6 to 8 feet below existing grade. Temporary excavations greater than 4 feet deep should be properly sloped or shored. All temporary excavations should be performed in accordance with Part N of WAC 296-155. The contractor is responsible for maintaining safe excavation slopes and/or shoring. The temporary cut slopes should be re-evaluated by a representative of Merit Engineering during construction based on actual observed soil conditions.

#### 8.3.2 Dewatering

No surface water was observed and no groundwater seepage was encountered during our site exploration on June 29, 2022. However, it may be anticipated the footing excavation will encounter groundwater due to fluctuation of seasonal water table and unforeseen circumstance of heavy rainfall in wet season. The contractor should be prepared to provide a temporary dewatering system to control and remove seepage into the excavations. Due to the relatively fine grained nature of the soils underlying the site, we anticipate groundwater seepage in the footing excavation can be controlled by sloping the base of the excavation to drain and removing the water with sumps and pumps.

### 8.4 Structural Fill

Structural fill should be placed on firm, horizontal subgrade in about 10-inch thick loose lifts and compacted to at least 95% of the ASTM D-1557 maximum dry density for footings, grade slab, parking and road, and sidewalks.

We recommend import structural fill be sandy gravel or gravelly sand meeting specification - 9-03.12 (1) B, APWA/DOT 2006, that is typical in this area as base granular materials with exception that percent passing U.S. No. 200 Sieve shall not exceed 5% and all materials smaller than 4″. The specification is summarized below:

**Table 2: Specification of Imported Fill Materials**

| Sieve Size | Percent Passing by Weight |
|---|---|
| 4″ Square | 100 |
| 2″ Square | 75-100 |
| U.S. No. 4 | 22-66 |
| U.S. No. 200 | 5.0 max. |
| Dust Ratio $\frac{\%\ Passing\ U.S.\ No.\ 200}{\%\ Passing\ U.S.\ No.\ 40}$ | ⅔ max. |
| Sand Equivalent | 30 min. |

Backfill immediately behind retaining walls or adjacent to foundation stem walls should be compacted to about 90% of the ASTM D-1557 maximum dry density. Care must be taken to avoid over-compaction immediately behind walls. Backfill behind retaining walls must be free draining material.

It is important that plumbing and utility trenches be properly backfilled. Backfill in the trenches should meet the appropriate compaction criteria described above.

### 8.5 Foundation Design Parameters

We recommend placing foundation on native dense glacial till soils or on import structural fill installed on the native glacial till soils. Sand sub grade soils should be compacted to 95% modified proctor. If site soils are not found to be firm at a footing location and grade, we recommend excavating down to appropriately firm soils and replacing the soft/loose soil section with structural fill.

We recommend that all perimeter footings be at least 18 inches below final outside grade for frost protection. The base width of footings shall be at least 18 and 24 inches for continuous and isolated column spread footings, respectively.

Under condition of satisfying the above recommended footing dimensions, a soil bearing pressure of 2,500 psf (*pounds per square foot*) is recommended. Bearing pressure may be increased by $^{1}/_{3}$ for transient wind or seismic loads. This bearing recommendation is preliminary pending building design details. We recommend that we be contacted in the design phase to evaluate building details with our soils and slope condition and revise bearing allowances accordingly.

With the above recommended soil bearing capacity, the anticipated load on the footings, and the soil conditions from the tests, we estimate that the total potential settlement of the foundations should be less than 1 inch. While most settlement will occur in the short term as loads are applied, some settlement may occur over a long period of time after construction.

We recommend proof-rolling building pads before placement of footings with a loaded dump truck to reveal soft or yielding surficial soils. Any soft subgrade soils encountered during site excavation or exposed during proof-rolling should be re-compacted.

We recommend that we review portions of plans and specifications pertaining to earthwork and foundations to ensure they are consistent with recommendations in this report.

We also recommend that we observe and verify site excavation to suitable soil stratum, a proof roll test to verify imported fill materials, and observe and test compaction of structural fill materials.

## *8.6 Foundation and Site Drainage*

A perimeter footing drainage system should consist of at least 6-inch diameter, perforated, rigid pipe. Pipes should be placed along the exterior base of the foundation perimeter and tightlined to a storm drain system or natural drain course. Pipe should be bedded on 2 inches, and backfilled with a minimum of 12-inches, of pea gravel.

Under-slab cross-drains may be helpful to maintain a dry slab floor to facilitate drainage. A cross-drain system should be overlain by drain rock beneath the slab.

Roof downspouts should be tightlined to a storm drain system separately from footing drains. In addition, the site should be graded so that surface water runoff is directed to catch basins attached to a storm sewer drain.

In addition, the site general perimeter drain shall be installed for general slope stability protection. And we recommend that we be retained to consult and review on the drainage installation work.

### 8.7 Slab-On-Grade Floor

A slab-on-grade floor may be supported on building pads that are prepared with firm native subgrade soils, or import structure fill compacted over firm native soils. At least 4-inches of drain rock of ¾″ maximum size should be placed between the slab and slab subgrade.

A vapor barrier visquine should be placed between the slab and capillary break material. An additional 1 to 2 inches of sand may be placed on top of the vapor barrier if desired to aid in concrete curing. In addition, use of a commercial concrete slab sealant for moisture protection may prove to be very helpful.

Floor slabs reinforced with 6 x 6 wire mesh may help reduce potential crack separation and vertical offsets at cracks. Reinforcement should be set at or above the mid-depth of the slabs. To reduce cracking potential we suggest exterior patios and other flatworks contain reinforcement as recommended above for floor slabs. Any flatwork subgrades should be watered thoroughly prior to concrete placement to close soil shrinkage cracks. Flatworks should have frequent joint controls.

Additional measures to reduce potential cracking are considered warranted at critical areas where slab movement could impair use; such critical areas include any exterior patio slabs that meet the interior floor level at doorways. For such areas we recommend that recommend that the upper 12-inches of native soil be over excavated and replace with import structural materials as specified in the Structural Fill section of this report.

### 8.8 Lateral Earth Pressure

We recommend that we be contacted for consultation and evaluation engineered retaining walls or walls with a surcharge loads are considered in site design. Addition of a retaining wall and backfill near the top or on a slope may cause undue loading and therefore surficial soil-slope instability, and it is preferable to limit or avoid such load application if possible. Retaining walls against the base of an existing slope or cut are acceptable given the wall will not change the current topography significantly.

We recommend placing structural fill behind subsurface and retaining wall. The horizontal thickness of the fill should be at least the height of the wall. For structural fill, as recommended in the Structural Fill section of this report with a level ground, the parameters of lateral earth pressures are listed in Table 3.

| Soil | Active $K_a$ | Passive, $K_p$ | At Rest, $K_o$ |
|---|---|---|---|
| Structural Fills | 0.28 | 3.54 | 0.44 |
| Equivalent Fluid Pressures* | | | |
| Structural Fills | 34 | 425 | 53 |

*Equivalent fluid pressure is the product of lateral earth pressure coefficient and the unit weight of the soil.

The soil parameters of lateral earth pressure for the on-site soils may be much stronger than those in the above table, however, it must be evaluated to confirm on site during construction when site excavation opens up the ground for visual observation.

Design of subsurface walls should include appropriate lateral load due to adjacent surcharge. Under uniform surcharge qo, lateral load due to a uniformly distributed lateral pressure σ, should be added to active and at rest soil lateral pressure, respectively as defined in the following equations:

$$\sigma = \begin{cases} K_a q_o & \text{for active case} \\ K_o q_o & \text{for at rest case} \end{cases}$$

A

coefficient of base friction of 0.55 and 0.45 may be used between concrete and structural fill and between concrete and native fine sandy soil, respectively. However, if passive pressures are used in conjunction with frictional resistance to determine lateral resistance to sliding, only 1/2 the value of passive pressure presented above should be used since larger strains are required to mobilize passive soil resistance as compared to frictional resistance.

## 8.9 Seismic Design Parameters

The site is located in the seismically active Puget Low lands. Deep focus earthquakes from subduction of the Juan de Fuca plate beneath the North American plate can cause amplified shaking at the ground surface due to seismic waves of different velocities interacting. Seismic waves propagate relatively slow through soft soils and considerably faster in rock. As a result, areas with softer soils underlain by rock tend to experience greater ground shaking than areas with little variation in the underlying substratum. Local building codes and design practices now consider the possible effects of soil conditions and large subduction related earthquake in the design of structures.

### 8.9.1 Liquefaction

Liquefaction is a phenomenon associated primarily with near surface saturated cohesionless soils under zero effective stress. Effective stress equals the confining pressure of the soil minus pore water pressure. When saturated cohesionless soils undergo cyclic seismic loading, the induced excessive pore pressure cannot dissipate and thus grows larger. When the pore pressure becomes equal to the confining pressure from the overburden load, the effective stress of the soil becomes zero and the soil lost its strength or stiffness and becomes liquefied. Foundation settlement and lateral movement could damage structures supported by liquefiable soils and sites with conditions favorable for liquefaction are designated as Site Class F. Site classes are a simplified method for describing the amplification of ground shaking during a seismic event due to effects of underlying soil conditions and are defined by a unique range of average shear wave velocities in the upper 100´ of the site soil column.

The site soils consist primarily of very dense till soil at shallow depth. Based on these soil, it is our opinion that liquefaction potential at the site is low because soils at the site are generally very dense sand with gravel.

### 8.9.2 Design Parameters

Using the results of our DCP (Dynamic Cone Penetration) test holes and geologic setting as discussed in this report, we estimate the average N value, using methods provided in Section 1613 of the 2018 IBC. The results of our average N value estimated and projected for a 100´ section indicate a very dense soil N > 50. Based on the results from our subsurface exploration the soil profile at the site may be defined as Site Class D according to IBC (International Building Code) 2018, representing a stiff soil. Seismic design parameters for this site class and location, from ASCE 7 Hazard Tool with ASCE/SEI 7-22 reference document, are summarized in the following table:

**Table 4: Spectral Response Acceleration (SRA)**

| SRA and Site Conditions | Short Period (0.2 sec) | 1- Second Period |
|---|---|---|
| Mapped SRA | $S_S = 1.6$ | $S_1 = 0.63$ |
| SITE CLASS D | | |
| Site Coefficients | $F_a = 1.0$ | $F_v = 1.858$ |
| Max. Considered Earthquake SRA | $S_{MS} = 1.71$ | $S_{M1} = 1.3$ |
| Design SRA | $S_{DS} = 1.14$ | $S_{D1} = 0.63$ |

# 9.GEOLOGIC HAZARD MITIGATION

## *9.1 Landslide Hazard Mitigation (LDC 19.07.100)*

Based on our subsurface exploration and literature research, we have determined that the site slope is composed of relatively shallow till soil. We have completed a slope stability analysis and determined that the steep slope is generally having a factor of safety greater than 1.5, which is considered acceptable for permanent important structures on steep slope area or adjacent area. Please note that the Puget Sound area is seismically active and there may be seismic hazards associated with the slope as discussed below.

A critical slope area and associated “No Building Buffer” area is typically designated (refer to chapter 9.4), which should not be developed in order to mitigate possible landslide and erosion hazards. This scenario is apparently not applicable to this site. The main concern with the proposed development involves loading or disturbing shallow cover soils in a manner that increases erosion or causes shallow slumps, surface creep, or subsidence. Our recommendations above are generally for cut grading to construct the proposed residence on the lower portion slope of the property and effectively support all the structures on dense soils. It is our opinion that the subject slope may not be adversely affected since the cut will be supported by an engineered retaining wall, and therefore, the proposed development will not increase the potential for landslide or erosion hazard if the recommendations in this report are followed.

### *9.2 Erosion Hazard Mitigation (LDC 19.07.100)*

The following general recommendations will assist in preventing high rates of erosion that may cause site slopes to become unstable during and after construction. Vegetation removal and ground disturbance on the slope should be limited to only as necessary in work areas. During construction if warranted or desired, soil containing measures such as silt fencing, hay bails, or straw waddles may be helpful in limiting erosion and the effects of earthwork activity on adjacent areas down slope. The contractor should comply with Best Management Practices (BMPs) and temporary erosion control measures as required.

The soil cutslope recommendations above are intended to reduce the overall area of ground disturbance while allowing for re-establishment of adequate slopes after construction. Care should be taken to restore disturbed or cleared areas to a naturalized state via plantings, control drainage and limit runoff onto these areas, and provide ongoing maintenance of vulnerable slope faces as needed in the long term, to minimize the potential for erosion and local soil slumps.

Construction and construction equipment should be confined to the areas of the building construction. It should be understood that the impacts of construction equipment and vegetation removal disturbs the soil and removes stabilizing rooting, causing the slope surface to be less stable. Equipment use on the slopes should be limited to light machinery.

We recommend drainage controls and appropriate outlets be applied as possible to limit the potential for slope instability due to water inundation. The on-site soil may cause areas of temporary saturation during storm events, especially around grading alterations and improvements. Features that may collect ground or surface water, should be designed with perforated pipe for water collection and drainage. Drainage pipes should be tightlined to a natural drain course or dispersed in an appropriate area below and away from slope faces.

Provided that the recommendations above are implemented, we conclude that the erosion hazard will be adequately mitigated during and after site development.

### *9.3 Seismic Hazard Considerations*

The seismic hazards has been addressed early in this report Section 8.9 Seismic Design Parameters.

### *9.4 Buffers and Setbacks (LDC 19.07.100)*

Based on subsurface conditions in conjunction with geologic setting, we recommend a “No Building Buffers” that extend from the northern boundary of proposed excavation for building pad up north to the elevation 101´ on the topographic survey map, which is approximately 40´ horizontal distance, as well as in directions of west and east beyond the building pad excavation. The purpose of the buffer is to prevent surcharge loads from being added to the slope surface soils to mitigate the risk of soil creep, subsidence, or surface slumps. No structures or typical shallow foundations should be constructed in the buffer zone. Deep foundations or pile foundations may be considered but should be evaluated on design specifics. Minor landscaping improvements, are acceptable in the buffer area as long as Best Management Practices (BMPs) and erosion controls are implemented. The critical slope area should generally not be disturbed.

# 10.GENERAL CONDITIONS

The recommendations provided herein are based on our understanding of the project at this time. We expect the on-site geologic conditions to reflect our findings, however, some variations may occur. Should soil conditions be encountered that cause concern and/or are not discussed herein, Merit Engineering, Inc. should be contacted immediately to determine if additional or alternate recommendations are required.

We recommend that we review those portions of the plans and specifications pertaining to earthwork, cutslopes, and wall design to ensure that they are consistent with the recommendations in this report.

We recommend that we verify site excavation to suitable soil stratum, verify imported fill materials, and observe and test compaction of structural fill. We recommend that we be retained to evaluate the condition of cutslopes once open, including soil condition, structures, and soil stability, and provide recommendations as needed for remediation or reinforcement of permanent cutbanks.

This report is prepared for Bin Zhang for specific application to the critical areas evaluation for the proposed development located at immediate west of 5425 96th Ave SE Mercer Island, Washington, in Mercer Island, Washington 98040 (Parcel #1438700145). This report has been prepared in accordance with generally accepted geotechnical/geological engineering practices in this area. No other warranty, expressed or implied, is made.

This report is an instrument of our professional service, and we (Merit Engineering, Inc.) shall retain an ownership and property interest therein. We grant Bin Zhang a license to use the instrument of our professional service for the purpose of constructing the above mentioned proposed improvements. We do not permit reuse or modification of this document for application to a different structure or location other than the proposed or to another property because soil and subsurface conditions are unique and site specific for different locations.

The STABLE computer model was calibrated using the observed slope height of ~26´. Should the slope height change, or soil conditions or other related parameters change, the calculations would be inaccurate and Merit Engineering, Inc. should be contacted to determine if alternate recommendations are required. We expect the onsite conditions to reflect our findings; however, some variations may occur. Should soil conditions be encountered that cause concern and/or are not discussed herein, Merit Engineering, Inc. should be contacted immediately to determine if additional or alternate recommendations are required.

Results presented in this report are based on our field tests and engineering analysis using the best available knowledge we have, which by no means gives any warranty or guarantee that slope failure after site development will not occur. We understand the owners have chosen and are ultimately willing to live an area that is a potential geohazard. Therefore, we recommend long term monitoring of the slope. Additionally, the owners and/or their representatives should understand that they are willing to take the risk to live in a geologically critical area and, therefore, agree to indemnify and hold Merit Engineering, Inc. harmless, including its owners and employees, for the property owners are ultimately responsible for the potential adverse consequences of living in a geologically critical area.

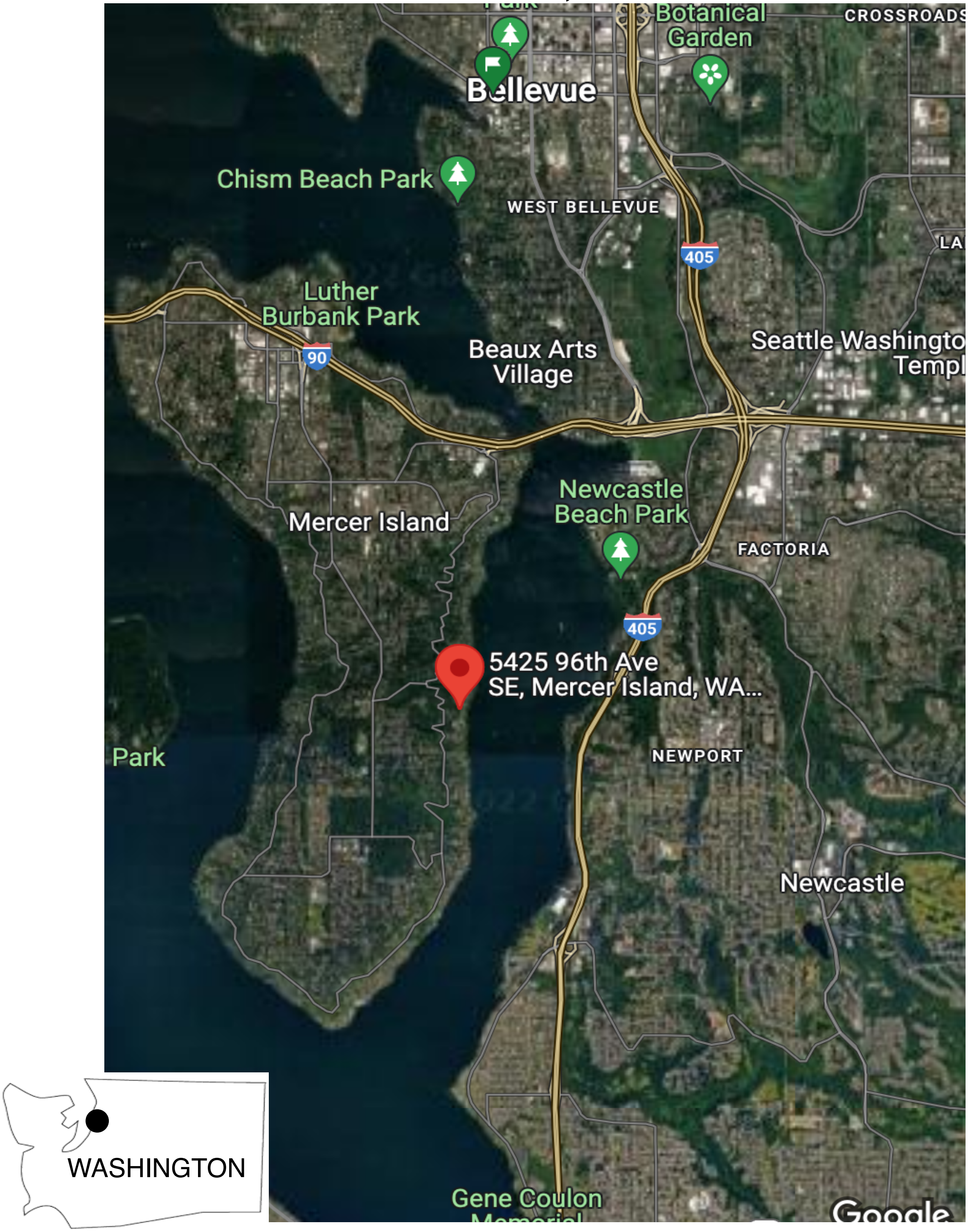
This study has used limited methods employed for evaluating slope conditions within the site and its vicinity, with limitations noted herein, as allowed within the reasonable scope of the project. This study does not attempt to perform an in-depth subsurface investigation of deep soils or bedrock, which is beyond the feasible scope and cost of the project at this time. The on-site soil condition should be reevaluated, if different soils are encountered during construction or if the deep excavation below current ground surface occur. We recommend that we be retained consult and review the soil conditions when subsurface open up or during the construction phase of the project to confirm they are in accordance with the soils encountered in this report. The owners should therefore understand that the soil conditions described herein are the result of surficial interpretations provided within the scope of this study, and thus are not intended to represent or substitute for a comprehensive study of subsurface conditions.

# APPENDIX

Subsurface conditions at the site were investigated by conducting three (3) DCP tests on June 29, 2022. DCP test locations were determined by a representative of Merit Engineering Inc. as shown approximately on the Site Plan (Figure 2) presented in the Appendix of this report. Tests were conducted near the adjacent to the building footprint to generalize subsurface soil conditions. Depths referred to in this report are relative to the existing ground surface at the time of this field investigation.

Descriptions of subsurface conditions are based on observations made at the site at the time of the field investigation. DCP test logs are presented in Figures 4 through 6. The soils observed at the site were classified using the USCS (Unified Soils Classification System ) in accordance with ASTM D-2488-69 and ASTM D 2487. This classification system is also presented in the Appendix (Figure 3).

# MERER ISLAND, WASHINGTON




| Project No. 2DF0422984 | **PROJECT LOCATION & VICINITY MAP** | 08/08/2022 | *Figure 1* |
|---|---|---|---|

Proposed Single Family House
5425 96th AVE SE
Mercer Island, Washington
Parcel 1438700145

Prepared For: Bin Zhang

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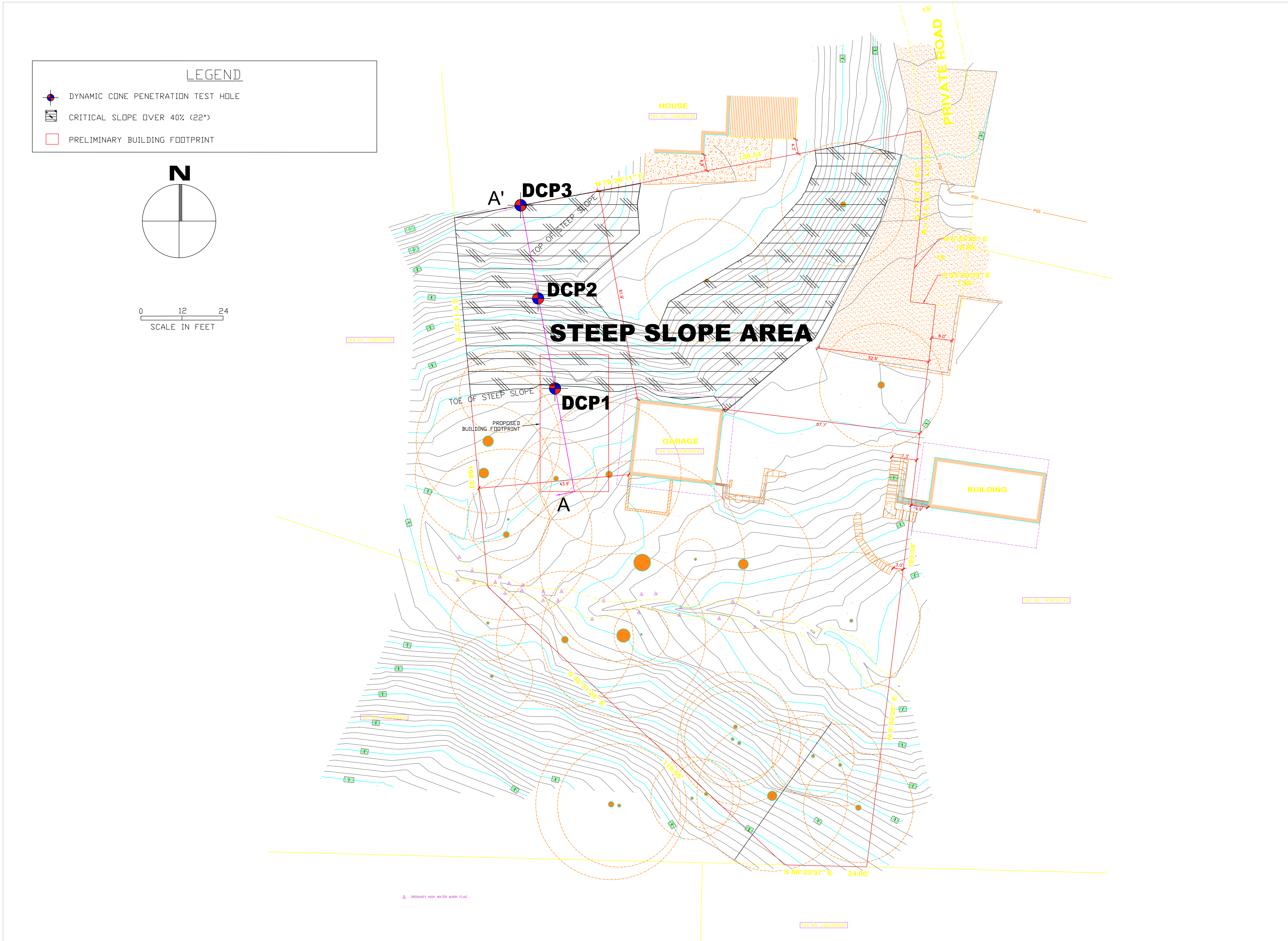


MERIT ENGINEERING INC.
10129 Main Street, #201
Bellevue, Washington 98004
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# SITE PLAN

| PROJECT NO. | DATE | APPROVED BY |
|---|---|---|
| 2DF0422984 | 08/08/2022 | AXH |

Single Family House Development
5425 96th Ave SE
Mercer Island, WA
Parcel Number: 1438700145

Figure 2 SCALE; 1"12'

Note: Property Lines and Topography based on the Survey From CHADWICK and WINTERS LAND SURVEYING and MAPPING

For: Bin Zhang

# UNIFIED SOIL CLASSIFICATION SYSTEM

| MAJOR DIVISIONS | | | | DESCRIPTION |
|---|---|---|---|---|
| COARSE GRAINED SOILS more than 50% retained on #200 sieve | GRAVELS more than 50% coarse fraction is larger than No. 4 sieve size | Gravels with less than 5% fines | GW | Well graded gravels, gravel-sand mixtures |
| | | | GP | Poorly graded gravels, gravel-sand mixtures |
| | | Gravels with more than 12% fines | GM | Silty gravels, gravel-sand-silt mixtures |
| | | | GC | Clayey gravels, gravel-sand-clay mixtures |
| | SANDS more than 50% coarse fraction is smaller than No. 4 sieve size | Sands with less than 5% fines | SW | Well graded sands, gravelly sands |
| | | | SP | Poorly graded sands, gravelly sands |
| | | Sands with more than 12% fines | SM | Silty sands, sand-silt mixtures |
| | | | SC | Clayey sands, sand-clay mixtures |
| FINE GRAINED SOILS more than 50% passing #200 sieve | SILTS AND CLAYS Liquid Limit less than 50 | | ML | Inorganic silts & very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity |
| | | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, or lean clays |
| | | | OL | Organic clays and organic silty clays of low plasticity |
| | SILTS AND CLAYS Liquid Limits greater than 50 | | MH | Inorganic silts, micaceous or diatomacious fine, sandy or silty soils, elastic silts |
| | | | CH | Inorganic clays of high plasticity, fat clays |
| | | | OH | Organic clays of medium to high plasticity, organic silts |
| HIGHLY ORGANIC SOILS | | | PT | Peat and other highly organic soils |
| UNCONTROLLED FILL | | | | Uncontrolled, with highly variable constituents |

# LEGEND

| SAMPLE | SYMBOL |
|---|---|
| SPLIT SPOON SAMPLER | ∇ GROUNDWATER TABLE |
| SHELBY TUBE SAMPLER | $q_u$ PENETROMETER READING TSF (*tons per square foot*) |

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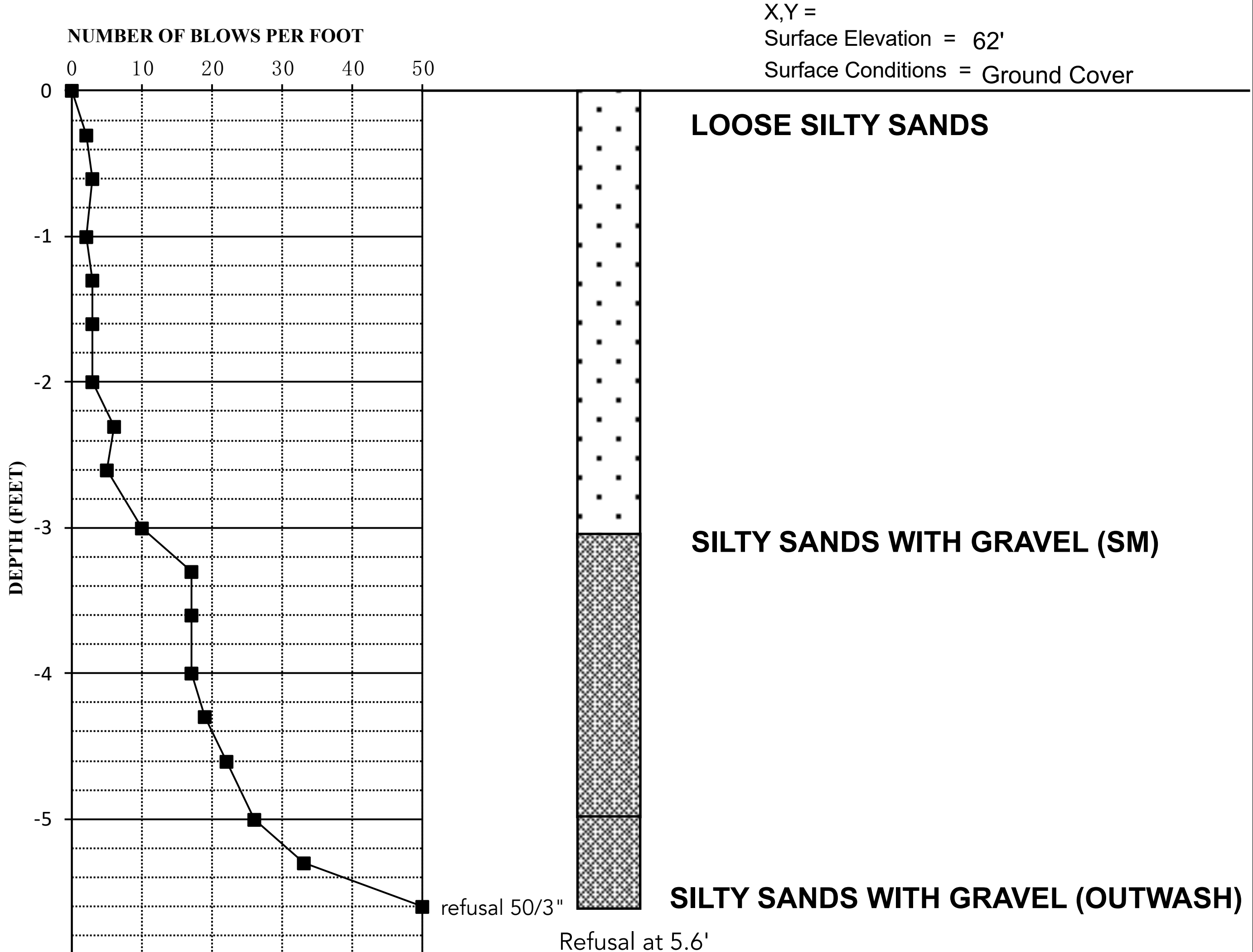
**SOIL CLASSIFICATION & LEGEND**

*Figure 3*

**DCP-1** DYNAMIC CONE PENETRATION TEST | SOIL DESCRIPTION AND CLASSIFICATION

X,Y =
Surface Elevation = 62'
Surface Conditions = Ground Cover




Note: Soil profile is inferred from CPT results. Subsrface conditions were not observed directly during DCP testing.

| Project No: P2BL0232711 | Date: 06/29/2022 | LOG OF DCP TEST | Approved by AXH | Figure 4 |
|---|---|---|---|---|

Proposed Single Family House
5425 96th Ave SE
Mercer Island, WA

Prepare For: Zhang Bin

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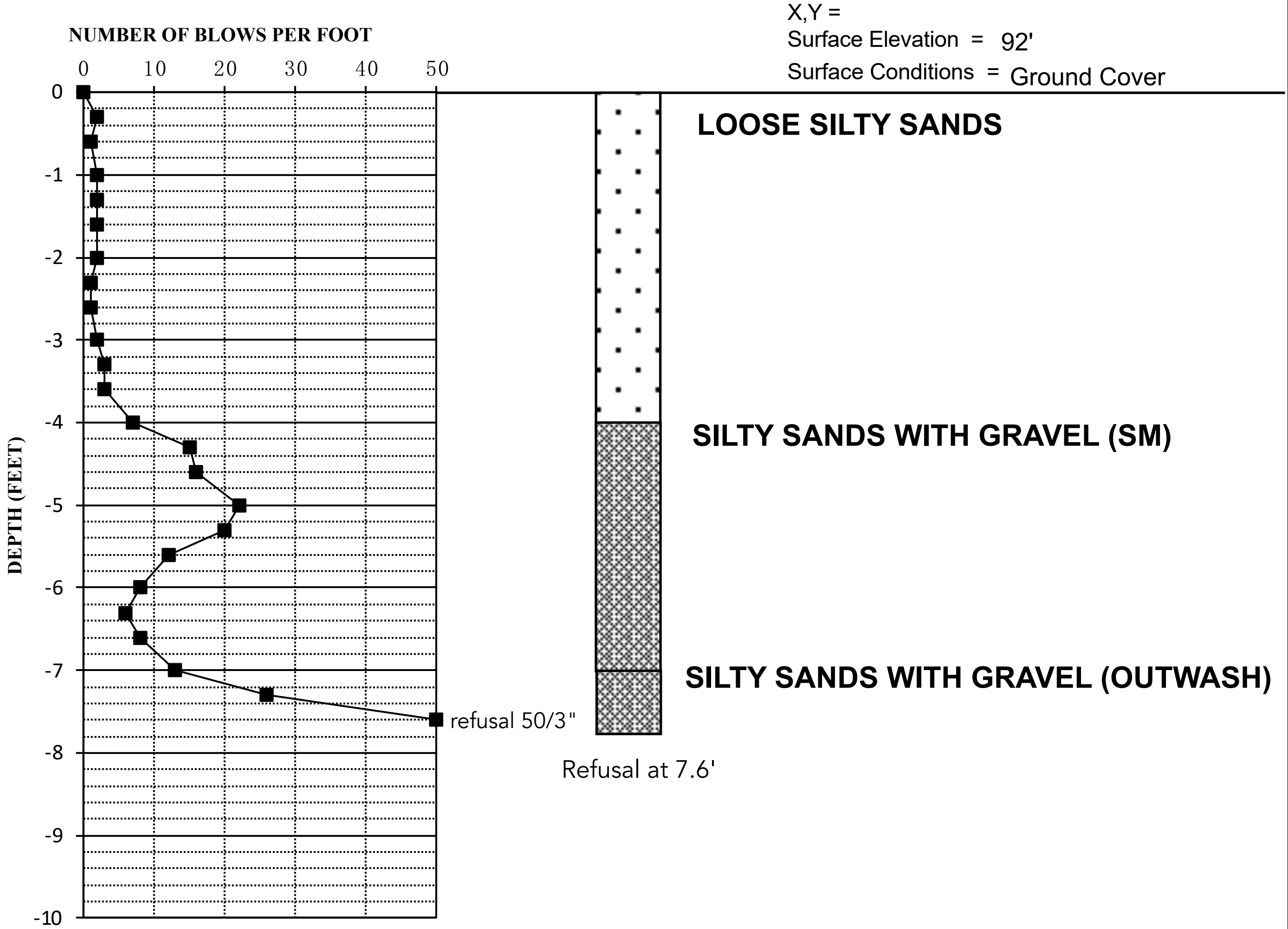
**DCP-2** DYNAMIC CONE PENETRATION TEST | SOIL DESCRIPTION AND CLASSIFICATION

X,Y =
Surface Elevation = 92'
Surface Conditions = Ground Cover




Note: Soil profile is inferred from CPT results. Subsrface conditions were not observed directly during DCP testing.

| Project No: P2BL0232711 | Date: 06/29/2022 | **LOG OF DCP TEST** | Approved by AXH | Figure 5 |
|---|---|---|---|---|

Proposed Single Family House
5425 96th Ave SE
Mercer Island, WA

Prepare For: Zhang Bin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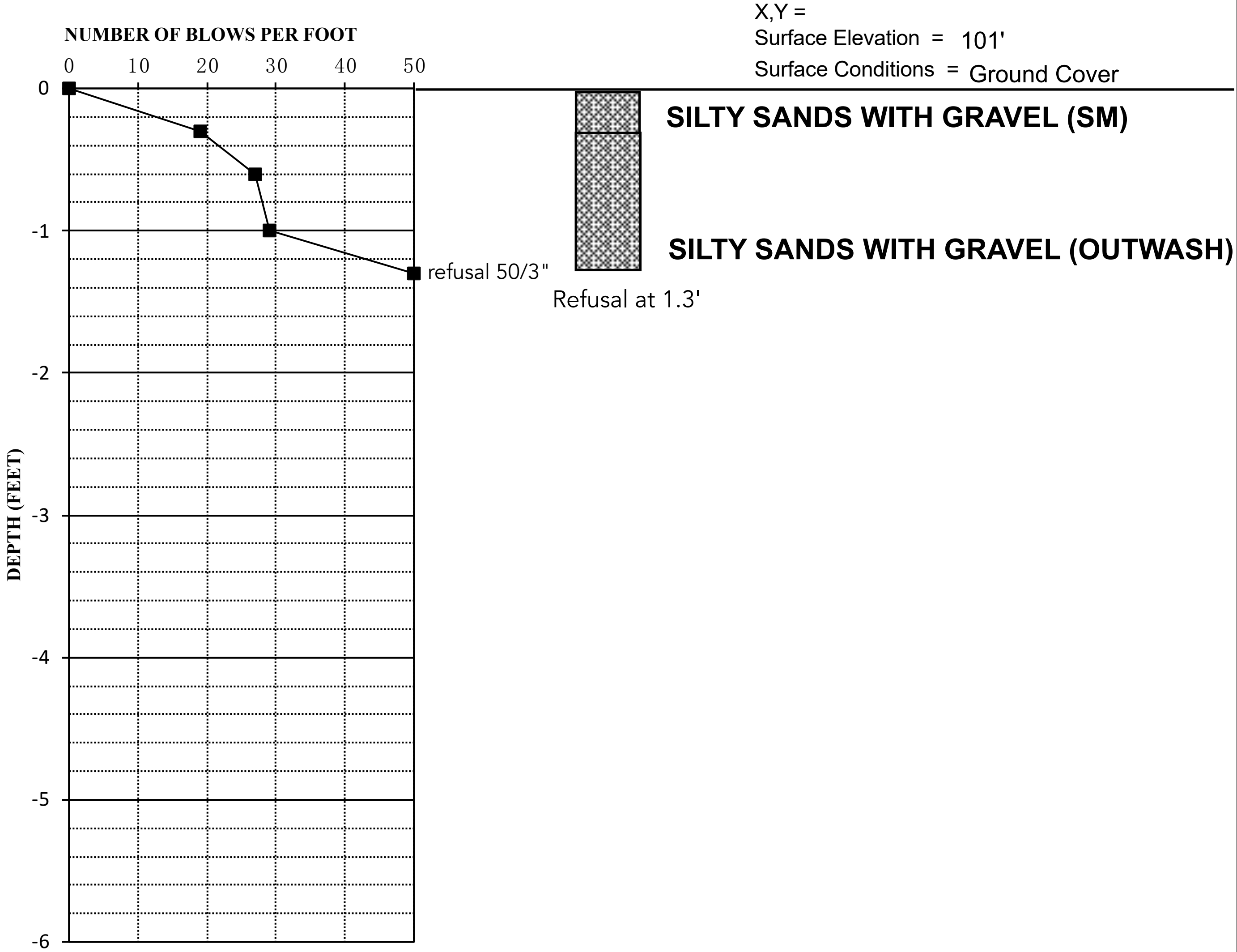
**DCP-3** DYNAMIC CONE PENETRATION TEST | SOIL DESCRIPTION AND CLASSIFICATION

X,Y =
Surface Elevation = 101'
Surface Conditions = Ground Cover




Note: Soil profile is inferred from CPT results. Subsrface conditions were not observed directly during DCP testing.

| Project No: P2BL0232711 | Date: 06/29/2022 | **LOG OF DCP TEST** | Approved by AXH | Figure 6 |
|---|---|---|---|---|

Proposed Single Family House
5425 96th Ave SE
Mercer Island, WA

Prepare For: Zhang Bin

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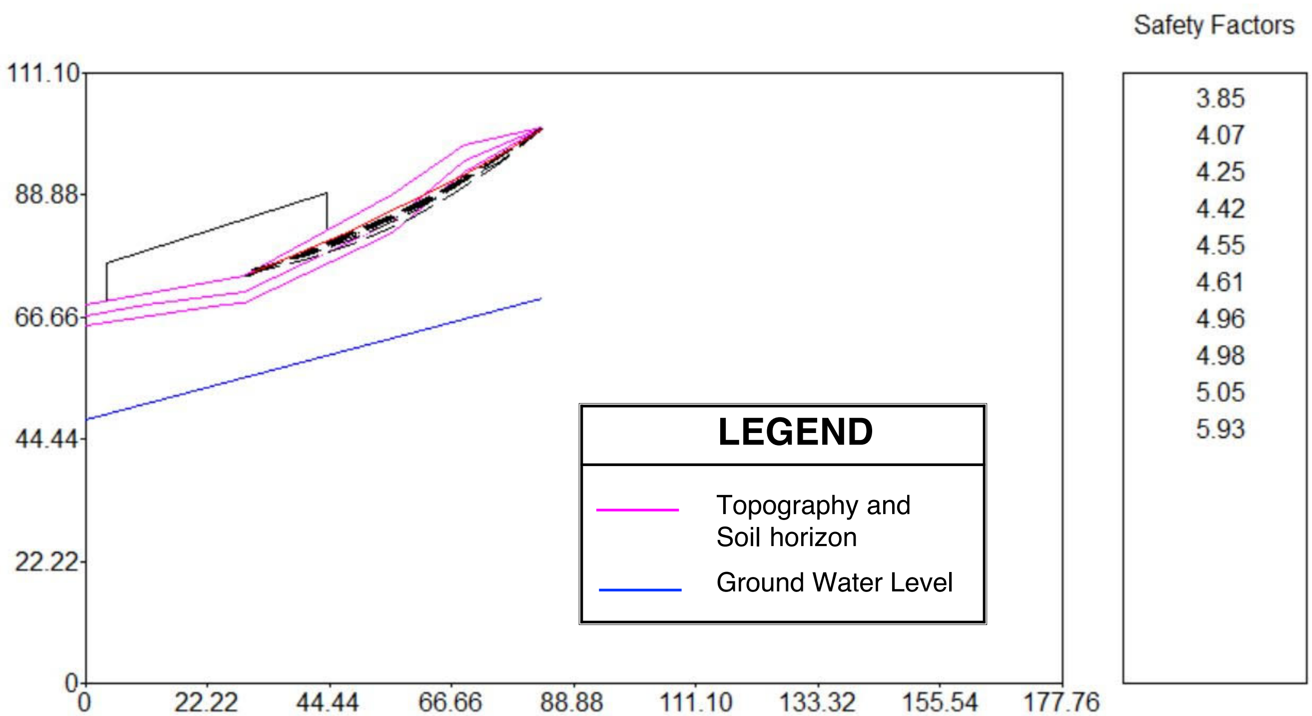
**STATIC CONDITION** | *Figure 7*




| Project No. P2BL0232711 | Date: 08/08/2022 | **CROSS SECTION A-A'** | Approved by A.X.H. | *No Scale* |
|---|---|---|---|---|

Single Family House Development
5425 96th Ave SE
Mercer Island, WA
Parcel number:1438700145

Prepared For: Bin Zhang

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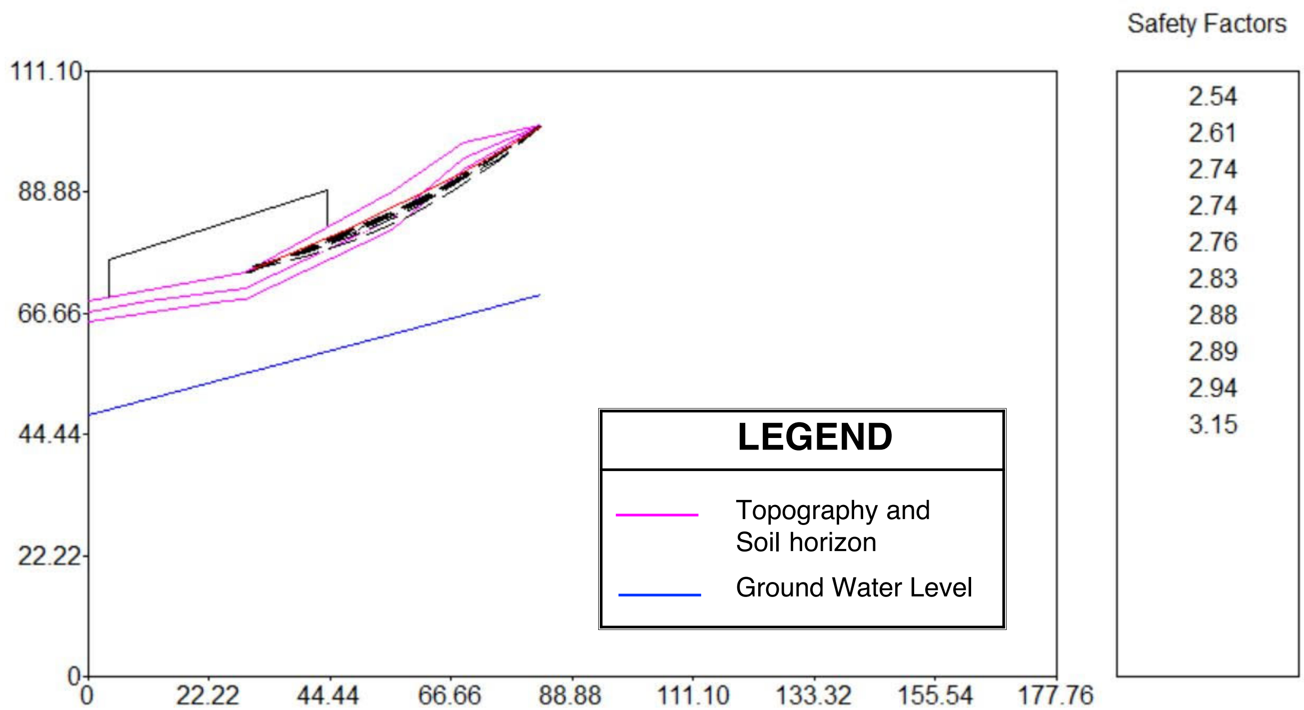
| **SEISMIC CONDITION** | *Figure 8* |
|---|---|




| Project No. P2BL0232711 | Date: 08/08/2022 | **CROSS SECTION A-A'** | Approved by A.X.H. | *No Scale* |
|---|---|---|---|---|

Single Family House Development
5425 96th Ave SE
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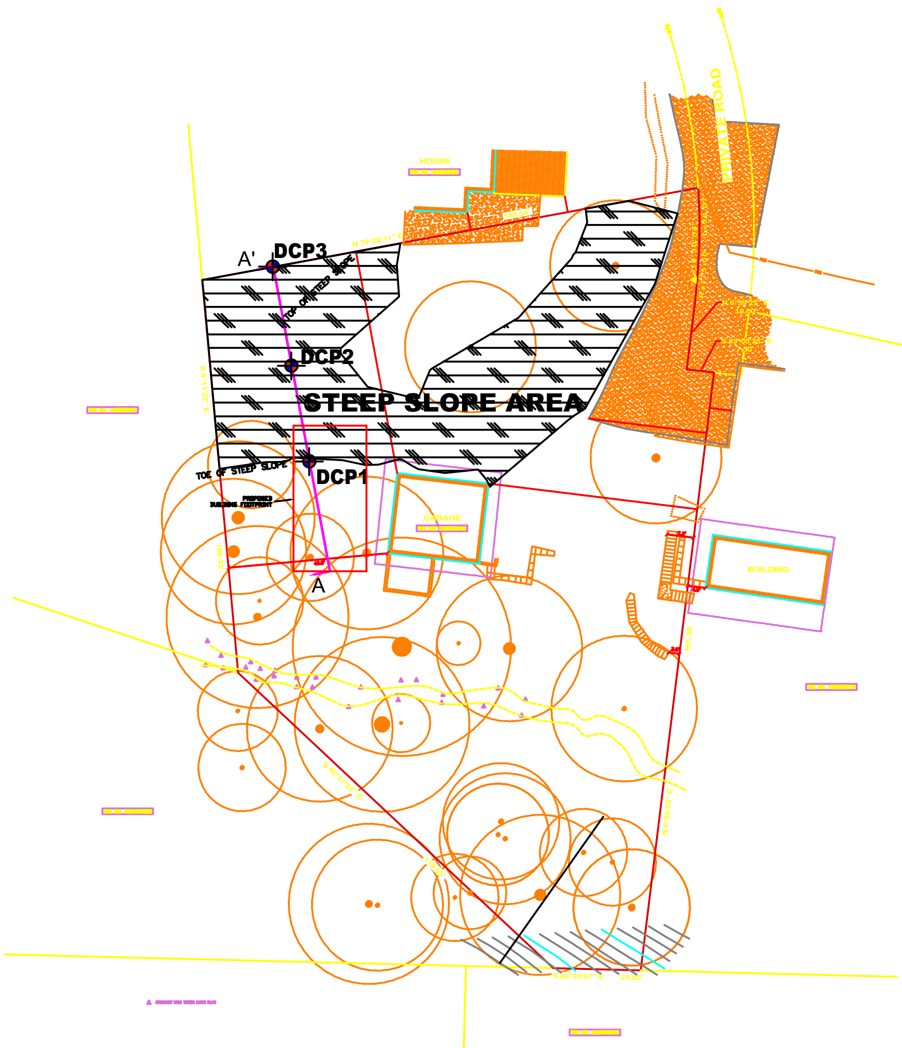


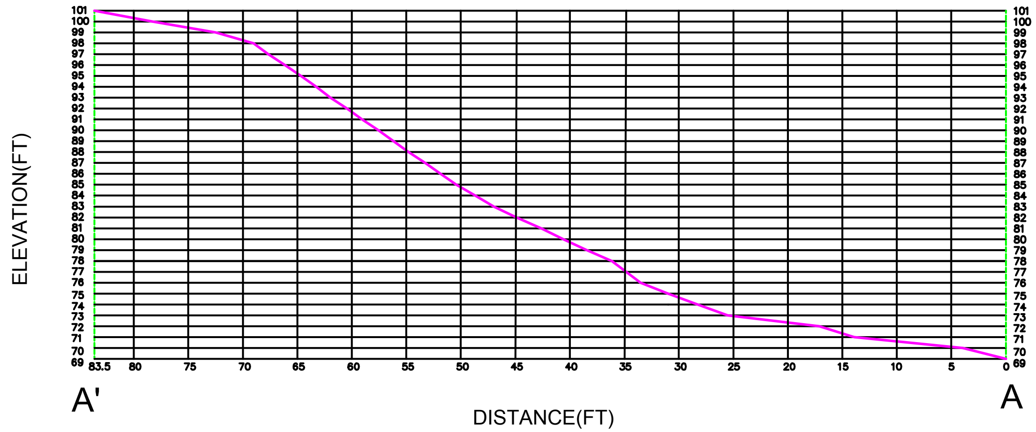


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|---|---|---|---|---|
| Note: Property Lines and Topogrphy based on the Survey From CHADWICK and WINTERS LAND SURVEYING and MAPPING | Single Family House Development<br>5425 96th Ave SE<br>Mercer Island, WA<br>Parcel Number: 1438700145 | CROSS - SECTION A-A' | | |
| Figure 9 | | PROJECT NO. | DATE | APPROVED BY |
| For: BIN ZHANG | SCALE: NOT ON SCALE | 2DF0422984 | 08/08/2022 | AXH |


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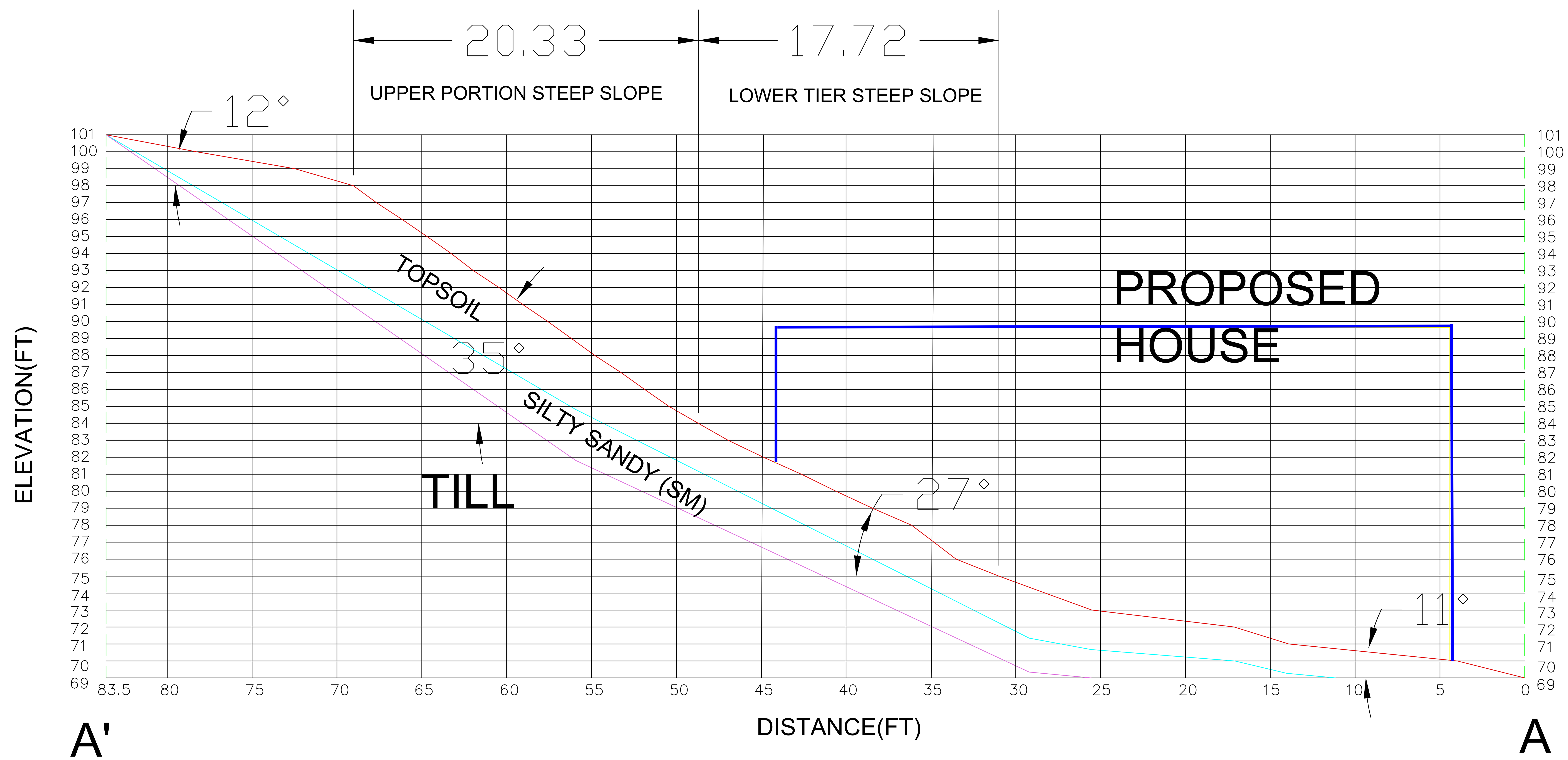


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| Note: Property Lines and Topogrphy based on the Survey From CHADWICK and WINTERS LAND SURVEYING and MAPPING | Single Family House Development<br>5425 96th Ave SE<br>Mercer Island, WA<br>Parcel Number: 1438700145 | CROSS - SECTION A-A' | | MERIT ENGINEERING INC.<br>10129 Main Street, #201<br>Bellevue, Washington 98004<br>Telephone: (425)454-2133<br>http://www.MeritEngineering.com |
| Figure 10 | | PROJECT NO. | DATE | APPROVED BY |
| For: BIN ZHANG | SCALE: NOT ON SCALE | 2DF0422984 | 08/08/2022 | AXH |