PRELIMINARY GEOTECHNICAL ENGINEERING STUDY
PROPOSED RESIDENCE
7431 EAST MERCER WAY
MERCER ISLAND, WASHINGTON

PREPARED FOR
MS. MELISSA YANG

PREPARED BY

CASCADE GEOTECHNW
4957 LAKEMONT BLVD SE, C-4, #325
BELLEVUE, WA 98006
(206) 491-0081

PROJECT NO. 2018-015
December 5, 2018

CASCADE GROUP INT. LLC
DBA CASCADE GEOTECHNW
4957 Lakemont Blvd SE, C-4, #325
Bellevue, WA 98006
(425) 649-0613

December 5, 2018
Project No. 2018-015

Ms. Melissa Yang
c/o Mr. Steve Long
Studio 19 Architects
207½ 1St Avenue S, Suite 300, Seattle, WA 98104

Subject: **Preliminary Geotechnical Engineering Study**
Proposed Residence
7431 East Mercer Way, Mercer Island, WA

Dear Ms. Yang,

As requested, Cascade GeotechNW LLC has performed a preliminary geotechnical engineering study for the above project. This report documents the subsurface conditions at the site and presents our preliminary geotechnical recommendations for the proposed development

Based on the borings drilled, the subsurface soils at the site consist of a layer of fill overlying stiff to very stiff silt, sandy silt, and clayey silt to at least 26½ feet below surface. Groundwater was not encountered within the drilling depth in the borings. However, very moist to wet soils were observed at about 17½ feet in boring B-1 during drilling.

In our opinion, the proposed project is feasible from a geotechnical standpoint. Based on the soil conditions and our understanding the design concept, in our opinion, the proposed residence may be supported by a mat foundation/structural slabs with thickened edge footings. It is our opinion that temporary excavations may be accomplished with unsupported, sloped open cuts.

Cascade GeotechNW appreciates the opportunity to be of service to you during the design phase of this project. Please contact us at if you have any questions or we can be of further assistance.

Respectfully submitted,

Michael Xue, P.E.
Principal Geotechnical Engineer

Encl.: Preliminary Geotechnical Engineering Study Report

TABLE OF CONTENTS

PRELIMINARY GEOTECHNICAL ENGINEERING STUDY
PROPOSED RESIDENCE
7431 EAST MERCER WAY
MERCER ISLAND, WASHINGTON

1.0 INTRODUCTION

This report presents the results of our preliminary geotechnical engineering study for the proposed residence at the above-referenced site. The purpose of our work was to evaluate the subsurface conditions at the site and provide preliminary geotechnical recommendations regarding foundation design, site grading, and retaining walls for the proposed development. Authorization to conduct the geotechnical engineering study was provided by Ms. Yang on November 13, 2018.

2.0 SITE AND PROJECT DESCRIPTION

The subject property is an approximately 9,850 square foot lot located at 7431 East Mercer Way in the City of Mercer Island, Washington. The approximate location of the site is shown on the Vicinity Map, Figure 1. The subject property is a rectangular-shaped vacant lot, accessed through 7435 East Mercer Way (see Figure 2). It is bordered by vacant lots to the west and south, and by existing single-family residences to the north and east. Based on review of topographic map and our field observations, the majority of the property is a relatively level concrete pad that is currently used as a tennis court. However, steep slopes (40% or greater) exist along most of the property lines.

Based on the information provided to us, we understand that it is proposed to construct a new single-family residence at the subject property. Design plans are not available at the time this report was prepared. However, we envision the proposed SFR will be a two-story wood frame structure with concrete slabs on grade. We anticipate that a new driveway will need to be constructed along the north property line to provide access to the proposed residence from East Mercer Way through 7435 property. We anticipate that site grading for the proposed construction will likely involve cuts and fill on the order of 4 feet for the house foundation construction, and fills up to 6 to 7 feet for the driveway construction.

The conclusions and recommendations outlined in this report are based on our current understanding of the proposed development, which is in turn based on the project information provided to us. If the above project description is incorrect, or the project information changes, we should be consulted to review the recommendations contained in this study and make modifications, if needed.

3.0 PROJECT SCOPE

The purpose of our geotechnical engineering study for the proposed development is to characterize subsurface conditions at the project site. The subsurface information obtained was used to develop preliminary geotechnical engineering recommendations pertinent to the design and construction of the subject project. The scope of our work for this project included the following tasks and work efforts:

1. Collect and review available geotechnical data in the site vicinity to form a basis for our field exploration.

2. Conduct a site reconnaissance to observe the existing site conditions, and to identify site conditions that may impact the proposed development from a geotechnical standpoint.

3. Drill two test borings at the site to explore the general subsurface conditions at the site.

4. Perform engineering analyses to develop preliminary engineering recommendations pertinent to the proposed development concept.

5. Preparation of a preliminary geotechnical report summarizing our work on the project and presenting our findings and preliminary geotechnical recommendations.

It should be noted that our proposed scope of work does not include an evaluation of chemical properties of soil and groundwater. Our scope also does not include evaluation of stormwater infiltration.

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 SITE GEOLOGY

The Geologic Map of Mercer Island (Troost and Wisher, 2006) mapped the surficial geologic unit at the subject site as Lawton Clay deposit (Qvlc). Lawton Clay deposits (Qvlc) are described by Troost, et al. as laminated to massive silt, clayey silt, and silty clay with scattered dropstones deposited in lowland proglacial lakes that were glacially-overridden. Lawton Clay deposits are typically very stiff to hard, and are generally weathered to medium stiff to stiff near the surface.

4.2 Subsurface Conditions

Two test borings (B-1 and B-2) drilled at the site generally encountered about 4½ feet of fill overlying native stiff to very stiff, silt, clayey silt, and sandy silt extending to the bottom of the borings at about 26½ and 16½ feet in B-1 and B-2, respectively. Please refer to the summary boring logs Figures A-1 and A-2 in Appendix A for details.

Groundwater was not encountered within the drilling depths during drilling. However, very moist to wet soils were observed on the soil sample between 17½ and 19 feet in boring B-1 during drilling. It should be noted that groundwater elevations and seepage rates are likely to vary depending on the season, local subsurface conditions, tidal fluctuations, and other factors. Groundwater levels and seepage rates are normally highest during the winter and early spring.

5.0 GEOLOGY HAZARDS ASSESSMENT

5.1 Landslide Hazards and Steep Slopes

The subject site is mapped within a potential landslide hazard area according to the City of Mercer Island's Geologic Hazards Map. The majority of the site is flat with concrete surface. However, steep slopes exist at the approximate southwestern corner of the site and on adjacent property to the west. Based on the review of topographic survey map and our site observations, the steep slopes at the subject and neighboring sites are about 18 to 20 feet in height.

A site reconnaissance of the subject property was conducted on November 27, 2018. During our site reconnaissance, we did not observe obvious evidence of recent slope instability or ground movement at the site. In our opinion, the soldier pile walls installed at the adjacent parcel north and northeast of the steep slope areas also improved the subject site stability. The concrete surface appears to be in relatively good condition with some cracks at the east end. Based on our field observations, the general topography at the site and vicinity, and the result of subsurface explorations, in our opinion, the subject site appears to be globally stable in its current configuration. Based on the current development concept and the fact the proposed construction will be confined in the developed areas with minor grading, it is also our opinion that the proposed single-family development concept as currently planned is feasible from a geotechnical engineering standpoint and will not adversely affect the overall stability of the site or adjacent properties, provided the project is properly design and constructed.

5.2 Seismic Hazards

Based on our review of the City of Mercer Island's Geologic Hazards Maps, the project site is mapped within a seismic hazard area. The City of Mercer Island Code defines seismic hazard areas as those areas subject to risk of damage as a result of earthquake-induced ground shaking, slope failure, and soil liquefaction or surface faulting. Based on the fine-grained soils and lack of static groundwater table, it is our opinion that the potential for soil liquefaction during an IBC-code level earthquake at the site is considered negligible. As such, in our opinion, special design consideration associated with soil liquefaction at the site is not necessary.

5.3 Erosion Hazards

The site is mapped within a potential erosion hazard area according to the City of Mercer Island's Geologic Hazards Map. Based on the soils encountered in the borings, the near-surface site soils are likely to exhibit low to moderate erosion potential if exposed to long periods of rains in the wet season. However, in our opinion, the erosion hazards at the site can be effectively mitigated with the best management practice during construction and with properly designed and implemented landscaping for permanent erosion control, based on the current design concept with anticipated minor grading.

During construction, the temporary erosion hazard can be effectively managed with an appropriate erosion and sediment control plan, including but not limited to installing silt fence at the construction perimeter, limiting removal of vegetation to the construction area, placing rocks or hay bales at the disturbed/traffic areas and on the downhill side of the project, covering stockpile soil or cut slopes with plastic sheets, constructing a temporary drainage pond to control surface runoff and sediment trap, placing quarry spalls at the construction entrance, etc. Permanent erosion control measures should include establishing vegetation, landscape plants, and hardscape established at the end of project, and reducing surface runoff to the minimum extent possible.

6.0 DISCUSSION AND RECOMMENDATIONS

6.1 General

Based on the subsurface conditions at the site, it is our opinion that the proposed development concept as currently planned is feasible from a geotechnical standpoint. In our opinion, the proposed residence may be supported by a mat foundation/structural slabs. Our recommendations for the seismic design, site grading, foundations, and retaining wall are presented in the following sections.

6.2 Seismic Design Parameters

The following table provides seismic design parameters for the site that are in conformance with the 2015 edition of the International Building Code (IBC), which specifies a design earthquake having a 2% probability of occurrence in 50 years (return interval of 2,475 years), and the 2008 USGS seismic hazard maps:

Table 1 – Summary Seismic Design Parameters per 2015 IBC

Site Class	Spectral Acceleration at 0.2 sec. (g)	Spectral Acceleration at 1.0 sec. (g)	Site Coefficients		Design Spectral Response Parameters	
	S_S	S_1	F_a	F_v	S_{DS}	S_{D1}
D	1.451	0.553	1.0	1.50	0.968	0.553

6.3 General Earthwork Recommendations

Based on the current design concept, we anticipate that site grading for the proposed project will likely consist of cuts and fill up to 4 to 5 feet feet for the building construction and about 6 to 7 feet for the driveway construction. The site grading should be observed by a qualified geotechnical engineer. It is important that the earthwork be observed to evaluate whether any undesirable/unsuitable materials are encountered during the excavation and scarification process, and whether the exposed soil/rock conditions are similar to those encountered in our exploration. The following subsections provide general guidelines for design of site grading and earthwork.

6.3.1 Site Preparation

Site preparation for the proposed project mainly includes removal of the existing concrete, site clearing, and excavations to the design subgrade. All debris resulted from demolition should be hauled away from the site. The stripped surface materials should be properly disposed off-site or be "wasted" on site in non-structural landscaping areas.

Following site clearing and excavations, the adequacy of the subgrade where structural fill, foundations, slabs, or pavements are to be placed should be verified by a representative of Cascade GeotechNW. The subgrade soil in the improvement areas, if recompacted and still yielding, should also be over-excavated and replaced with compacted structural fill or lean-mix concrete.

6.3.4 Material Reuse and Structural Fill Materials

In the context of this report, structural fill is defined as compacted fill placed under footings, concrete stairs and landings, and slabs, or other load-bearing areas. In our opinion, the on-site fill and fine-grained soils are not suitable to be used as structural fill. Structural fill should consist of imported, well-grade, granular material, such as WSDOT Gravel Borrow (WSDOT 9-03.14(1)) or approved equivalent. Well-graded recycled concrete may also be considered as a source of structural fill. Use of recycled concrete as structural fill should be approved by the geotechnical engineer. The on-site fill may be used as general fill in the non-structural and landscaping areas. If use of the on-site soil is planned, the excavated soil should be stockpiled and protected with plastic sheeting to prevent softening from rainfall in the wet season.

6.3.5 Structural Fill Placement and Compaction Requirements

Structural fills should be placed in thin horizontal lifts not exceeding 10 inches in loose thickness, moisture conditioned to within about 3 percent of optimum moisture content, and systematically compacted to meet the following minimum relative densities based on the maximal dry density as determined using test method ASTM D 1557.

Table 2 – Structural Fill Compaction Requirements

Application	**Percentage**
Beneath conventional strip & column footings, patios, porches, and slab-on-grade floors	95%
Beneath roadways, driveways, pavement areas, sidewalks and backfill behind retaining & basement walls (required for backfill next to vertical drain mats).	95% for the top 12 inches and 90-95% below 12 inches

Observations and soil density tests should be performed during grading operations to assist the contractor in obtaining the required degree of compaction and the proper moisture content on each fill lift. Where compaction is less than required, additional compactive effort should be applied with adjustment of moisture content as necessary, to obtain the specified compaction.

6.3.6 Permanent Cut and Fill Slopes

Permanent cut and fill slopes should be graded no steeper than 2H:1V. Erosion control measures such as erosion-control mats and/or vegetation should be applied to the permanent slopes as soon as feasible.

6.4 Building Foundations

Based on the subsurface conditions at the site and our understanding of the design concept, we recommend that a mat foundation/structural slab with thickened edge bearing on 12-inch of structural fill be used to support the proposed building. The mat foundation/structural slab with thickened edge will provide a better foundation support and improve the long-term foundation performance. The following sections present our recommendations for designing the mat foundation/structural slab with thickened edge.

The mat foundation/structural slabs should bear on 12 inches of structural fill compacted to a dense condition. The native foundation subgrade soil at the bottom of 12 inches of structural fill should be in a firm condition or be re-compacted to a firm and unyielding condition prior to placement of structural fill. Any soft/loose and pumping native subgrade soil detected during compaction should be removed and replaced with structural fill or CDF. The foundation should be thickened a minimum depth of 18 inches below the adjacent finish grade around the perimeter of the mat. The thickened edge of the structural slabs should have a minimum width of 18 inches. For design of the mat foundation/structural slab with thickened edge bearing on the prepared subgrade as discussed above, a modulus of subgrade reaction, k_s, of 100 pounds per cubic inch (pci) may be used. With the mat foundation/structural slab foundation, we anticipate the average bearing pressure to be less than 2,000 psf.

Provided the mat slab subgrade is prepared as described above, mat foundation/structural slab settlement is estimated to be approximately one inch with differential settlement on the order of ½ inch.

Lateral Resistance

Lateral loads acting on the foundations may be resisted by passive earth pressure developed against the embedded portion of the foundation system and by frictional resistance at the bottom of the footings. For footings bearing on the competent native soil or compacted structural fill, a frictional coefficient of 0.35 may be used to evaluate sliding resistance. Passive soil resistance may be calculated using an equivalent fluid unit weight of 300 pcf, assuming properly re-compacted native soil or compacted structural fill will be placed against the footings. The above values include a factor of safety of 1.5. Unless covered by pavements or slabs, the passive resistance in the upper 12 inches of soil should be neglected.

Perimeter Footing Drain

Footing drains should be installed around the perimeter of the building, at or just below the invert of the footings. However, if clean sand is present at and below the footing bottom during construction, footing drains may be omitted. Under no circumstances should roof downspout drain lines be connected to the footing drain systems. Roof downspouts must be separately tightlined to a suitable discharge point. Cleanouts should be installed at strategic locations to allow for periodic maintenance of the footing drain and downspout tightline systems.

Foundation Subgrade Preparation

All foundation subgrades should be carefully prepared. The foundation subgrade should be in a dense condition or be compacted to a dense condition prior to concrete pour. If the on-site soil cannot be compacted to a dense condition, they should be over-excavated 12 inches and replaced with compacted structural fill. Foundation excavations should be observed by Cascade GeotechNW to confirm that the exposed footing subgrade is consistent with the expected conditions and adequate to support the design bearing pressure.

6.5 RETAINING AND BASEMENT WALL DESIGN PARAMETERS

Retaining and basement walls should be properly designed to resist the lateral earth pressures exerted by the soils behind the wall. Proper drainage provisions should also be provided behind the walls to intercept and remove groundwater that may be present behind the wall. Our geotechnical recommendations for the design and construction of the retaining/basement walls are presented below.

6.5.1 Lateral Earth Pressures

Concrete cantilever walls should be designed for an equivalent fluid pressure of 35 pcf for level backfills behind the walls assuming the walls are free to rotate. If walls are to be restrained at the top from free movement, such as basement walls, equivalent fluid pressures of 45 pcf should be used for level backfills behind the walls. Walls with a maximum 2H:1V backslope should be designed for an active and at rest earth pressure of 45 and 55 pcf, respectively.

Permanent walls should be designed for an additional uniform lateral pressure of 8H psf for seismic loading, where H corresponds to the buried depth of the wall. The recommended lateral pressures assume that the backfill behind the wall consists of a free draining and properly compacted fill with adequate drainage provisions.

6.5.2 Surcharge

Surcharge loads, where present, should also be included in the design of retaining walls. We recommend that a lateral load coefficient of 0.3 be used to compute the lateral pressure on the wall face resulting from surcharge loads located within a horizontal distance of one-half wall height.

6.5.3 Lateral Resistance

Lateral forces from seismic loading and unbalanced lateral earth pressures may be resisted by a combination of passive earth pressures acting against the embedded portions of the foundations and by friction acting on the base of the foundations. Passive resistance values may be determined using an equivalent fluid weight of 300 pcf. This value includes a factor of safety of 1.5, assuming the footing is poured against dense native sand, re-compacted on-site sandy soil or properly compacted structural fill adjacent to the sides of footing. A friction coefficient of 0.35 may be used to determine the frictional resistance at the base of the footings. The coefficient includes a factor safety of 1.5.

6.5.4 Wall Drainage

Provisions for wall drainage should consist of a 4-inch diameter perforated drainpipe behind and at the base of the wall footings, embedded in 12 to 18 inches of clean crushed rock and pea gravel wrapped with a layer of filter fabric. Where applicable, in-lieu of conventional footing drains, weep holes (2" diameter of 10 feet on center) may be used for site retaining walls. A minimum 18-inch wide zone of free draining granular soils (i.e. pea gravel or washed rock) is recommended to be placed adjacent to the wall for the full height of the wall. Alternatively, a composite drainage material, such as Miradrain 6000, may be used in lieu of the clean crushed rock or pea gravel. The drainpipe at the base of the wall should be graded to direct water to a suitable outlet.

6.5.5 Wall Backfill

Based on the field exploration, the on-site soil would not be suitable for wall backfill due to its high fines content. Where wall backfill is needed, we recommend using free draining granular soils, such as WSDOT gravel barrow or clean crushed gravel. In areas where the space is limited between the wall and the face of excavation, 5/8" clean crushed rock or pea gravel may be used as backfill without compaction.

Wall backfill should be moisture conditioned to within about 3 percent of optimum moisture content, placed in loose, horizontal lifts less than 8 inches in thickness, and systematically compacted to a dense and relatively unyielding condition and to at least 95 percent of the maximum dry density, as determined using test method ASTM D 1557. Within 5 feet of the wall, the backfill should be compacted with hand-operated equipment to at least 90 percent of the maximum dry density.

6.6 Temporary Excavations and Shoring

6.6.1 Unsupported Open Cuts

In general, we anticipate site excavations to encounter a few feet of fill over very stiff to very stiff silt. All temporary excavations should be performed in accordance with Part N of WAC (Washington Administrative Code) 296-155. The contractor is responsible for maintaining safe excavation slopes and/or shoring. Excavations more than a total of 4 feet deep should be properly shored or sloped. For planning purposes, it is our opinion that temporary excavations may be sloped as steep as 1H:1V in the dry season, and should be sloped 1½H:1V in the wet season. Where space may be limited, the use of L-shaped footings may be required to conserve space for the temporary cuts.

The temporary excavations and cut slopes should be re-evaluated by a qualified geotechnical engineer in the field during construction based on actual observed soil conditions, and may need to be modified in the wet reasons. The cut slopes should be covered with plastic sheets in the raining season. We also recommend that heavy construction equipment, building materials, excavated soil, and vehicular traffic should not be allowed within a distance equal to 1/3 the slope height from the top of any excavation.

6.6.2 Temporary Shoring

The detailed project design plans have not been developed yet. In our opinion, temporary shoring is not needed for the building foundation construction. However, temporary shoring may potentially be needed for the driveway construction. If needed, Cascade GeotechNW can provide shoring design recommendations if requested.

6.7 Building Setback Distance

Based on review of site topographic survey map and our field observations, the slope in the western portion of the site ranges about 18 to 20 feet in height. Based on the slope inclination, the total slope height, and the soil conditions encountered in our borings, it is our opinion that the proposed building should have a setback distance of 10 feet from the steep slopes. Additionally, the need for a catchment wall at the southwest corner of the site should be evaluated during design once the project design plans are finalized.

6.8 Wet Weather Construction

In our opinion, the proposed site construction may be accomplished during wet weather (such as in winter) without adversely affecting the site stability. However, earthwork construction performed during the drier summer months likely will be more economical. Winter construction will require the implementation of best management erosion and sedimentation control practices to reduce the chance of off-site sediment transport. Some of the site soils contain a high percentage of fines and are moisture sensitive. Any footing subgrade soils that become softened either by disturbance or rainfall should be removed and replaced with structural fill, CDF, or lean-mix concrete. General recommendations relative to earthwork performed in wet conditions are presented below:

- Site stripping, excavation and subgrade preparation should be followed promptly by the placement and compaction of clean structural fill or CDF;
- The size and type of construction equipment used may have to be limited to prevent soil disturbance;
- The ground surface within the construction area should be graded to promote run-off of surface water and to prevent the ponding of water;
- Geotextile silt fences should be strategically located to control erosion and the movement of soil;
- Structural fill should consist of less than 5% fines; and
- Excavation slopes should be covered with plastic sheets.

All permanent cut and fill slopes should be protected so that erosion will not occur. Vegetation should be established as soon after construction as possible to provide long-term erosion protection of the slopes. Prior to establishing vegetation, silt fences and straw bales staked along contours and slopes are recommended to reduce erosion. The slopes should be periodically monitored until vegetation has become fully established.

6.9 SURFACE DRAINAGE AND EROSION CONTROL

Surface runoff can be controlled during construction by careful grading practices. Typically, this includes the construction of shallow, upgrade perimeter ditches or low earthen berms in conjunction with silt fences to collect runoff and prevent water from entering excavations or to prevent runoff from the construction area from leaving the immediate work site. Temporary erosion control may require the use of hay bales on the downhill side of the project to prevent water from leaving the site and potential storm water detention to trap sand and silt before the water is discharged to a suitable outlet. All collected water should be directed under control to a positive and permanent discharge system.

Permanent control of surface water should be incorporated in the final grading design. Adequate surface gradients and drainage systems should be incorporated into the design such that surface runoff is directed away from structures. We suggest that the ground surface be sloped at a gradient of 3 percent for a distance of at least 10 feet feet away from the building, except in paved areas, which can be sloped at a gradient of 1 percent. Potential problems associated with erosion may also be reduced by establishing vegetation within disturbed areas immediately following grading operations.

Roof downspouts should be tightlined to discharge into the storm-water collection system separately from any footing drain system. Cleanouts should be installed at strategic locations to allow for periodic maintenance of the downspout tightline system.

7.0 STATEMENT OF RISK

We understand that the site contains geologic hazard areas, specifically as steep slopes and potential landslide, erosion, and seismic hazard areas. Per Mercer Island City Code Section 19.07.060.D.2, development within geologic hazard areas and critical slopes may occur if the geotechnical engineer provides a statement of risk with supporting documentation indicating that one of the following conditions can be met:

a. The geologic hazard area will be modified, or the development has been designed so that the risk to the lot and adjacent property is eliminated or mitigated such that the site is determined to be safe; or

b. An evaluation of site specific subsurface conditions demonstrates that the proposed development is not located in a geologic hazard area; or

c. Development practices are proposed for the alteration that would render the development as safe as if it were not located in a geologic hazard area; or

d. The alteration is so minor as not to pose a threat to the public health, safety, and welfare.

Based on the results of our geotechnical evaluation, it is our opinion that the site is stable in its existing condition. It is also our opinion that the proposed development meets the criteria (c) above, as the foundation elements designed and constructed per our recommendations should adequately mitigate potential geologic hazards from impacting the subject and surrounding properties. The adequacy of the temporary erosion and sediment control measures should be monitored during construction, especially in the wet season, by Cascade GeotechNW and may be modified as necessary according to the site and weather conditions. Permanent erosion control measures including landscape and hardscape installations will effectively mitigate the risk of erosion in the long term.

8.0 ADDITIONAL GEOTECHNICAL SERVICES

It should be noted that the preliminary geotechnical recommendations contained in this report are based on the subsurface conditions encountered at the site and the future design concept we envisioned based on the limited information provided to us. Additional geotechnical study including additional field exploration, if warranted, and engineering analysis may likely be required to update our recommendations contained in this report once the development plans are developed and finalized.

To confirm that our recommendations are properly incorporated into the design and construction of the proposed development, Cascade GeotechNW should also be retained to conduct a review of the final project plans and specifications. It is recommended that Cascade GeotechNW be retained to provide monitoring and testing services for geotechnical-related work during construction. This is to observe compliance with the intent of the design concepts, specifications, and/or recommendations, and to allow design changes in the event when subsurface conditions differ from those anticipated during design. The recommendations presented in this report are contingent upon the above observations.

Modifications to our recommendations presented in this report may be necessary, based on the actual conditions encountered during construction.

9.0 LIMITATIONS

This report has been prepared for the exclusive use of Ms. Melissa Yang and the project team for specific application to the proposed development. This report is intended to provide geotechnical recommendations based on a site reconnaissance, review of pertinent subsurface information, and our understanding of the project. The study was performed using a mutually agreed-upon scope of work.

Variations in soil conditions may exist between the locations of the explorations and the actual conditions underlying the site. The nature and extent of soil variations may not be evident until construction occurs. If any soil conditions are encountered at the site that are different from those described in this report, we should be notified immediately to review the applicability of our recommendations. Additionally, we should also be notified to review the applicability of our recommendations if there are any changes in the project scope.

The scope of our work does not include services related to construction safety precautions. 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. Additionally, the scope of our work specifically excludes the assessment of environmental characteristics, particularly those involving hazardous substances. We are not mold consultants nor are our recommendations to be interpreted as being preventative of mold development. A mold specialist should be consulted for all mold-related issues.

This report has been prepared for planning and design purposes for specific application to the proposed project in accordance with the generally accepted standards of local practice at the time this report was written. No warranty, express or implied, is made.

This report may be used only by the client and for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both off and on-site), or other factors including advances in our understanding of applied science, may change over time and could materially affect our findings. Therefore, this report should not be relied upon after 24 months from its issuance. Cascade GeotechNW should be notified if the project is delayed by more than 24 months from the date of this report so that we may review the applicability of our conclusions considering the time lapse.

It is the client's responsibility to see that all parties to this project, including the designer, contractor, subcontractors, etc., are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk. Any party other than the client who wishes to use this report shall notify Cascade GeotechNW of such intended use and for permission to copy this report. Based on the intended use of the report, Cascade GeotechNW may require that additional work be performed and that an updated report be reissued. Noncompliance with any of these requirements will release Cascade GeotechNW from any liability resulting from the use this report.

We appreciate the opportunity to be of service.

Sincerely,

12/5/2018

H. Michael Xue, P.E.
Principal Geotechnical Engineer

10.0 REFERENCES

Booth, D. B., Troost, K. A., and Wisher, A. P., 2007, *The Geologic Map of King County, Washington: scale 1:100,000*.

International Code Council, 2015, *International Building Code (IBC)*.

WSDOT, 2018, *Standard Specifications for Road, Bridges, and Municipal Construction.*

N

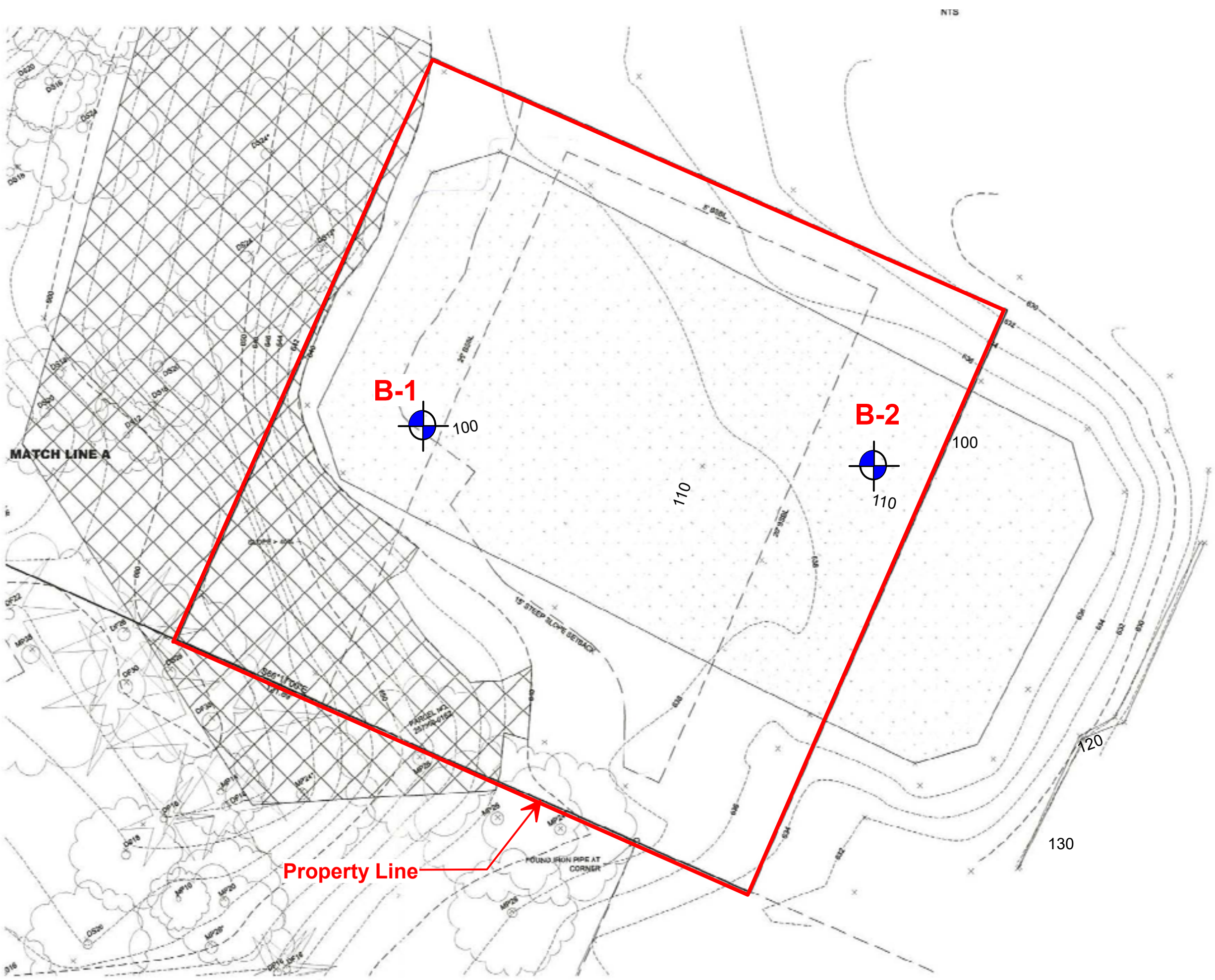
Not to Scale

Base Map: Google Maps

Cascade GeotechNW	**Proposed Residence** **9431 E Mercer Way** **Mercer Island, WA**	**VICINITY MAP** Project No. **2018-015** Figure No. **1**

file.grf w/ file.dat 12/4/18 (08:13) SDD

Site PlanL.grf w/ [file.jpg] 12/4/18 (08:43) HMX



Approx. Scale
1" = 30'

Note: Basemap modified from Topographic Survey Map prepared by Site Surveying Inc.

Legend:

B-1 Approx. Test Boring Location

Cascade GeotechNW	**Proposed Residence** **7431 E Mercer Way** **Mercer Island, Washington**	**SITE AND EXPLORATION PLAN**	
		Project No. **2018-015**	Figure No. **2**

APPENDIX A

FIELD EXPLORATION

The subsurface conditions at the site were explored by drilling two test borings (B-1 and B-2) to depths of 26.5 and 16.5 feet in B-1 and B-2, respectively on November 27, 2018. The approximate locations of the test boring are shown on the Site Exploration Plan, Figure 2. The borings were drilled with a hand-operated portable drill rig owned and operated by CN Drilling of Seattle, Washington.

The drill rig was equipped with 4-inch outside diameter hollow stem augers. Soil samples were obtained from the borings at 2½- and 5-foot depth intervals in general accordance with Standard Penetration Test (SPT) sampling methods (ASTM test method D-1586) in which the samples are obtained using a 2-inch outside diameter split-spoon sampler. The sampler was driven into the soil a distance of 18 inches using a 140-pound weight freely falling a distance of 30 inches. The number of blows required for each 6-inch increment of sampler penetration was recorded. The number of blows required to achieve the last 12 inches of sample penetration is defined as the SPT N-value. The N-value provides an empirical measure of the relative density of cohesionless soil, or the relative consistency of fine-grained soils.

An engineer from Cascade GeotechNW was present during the field exploration to observe the drilling, assist in sampling, and to describe and document the soil samples obtained from the borings. The soil samples were described and field classified in general accordance with the symbols and terms outlined in Figures A-3 and A-4, and the summary boring logs are included as Figures A-1 and A-2.

Date Started:	11/27/2018	Drill Rig:	Acker Portable Rig
Date Completed:	11/27/2018	Drilling Method:	4" Hollow Stem Auger
Logged by:	MX	Driving Energy:	140 lb. wt., 30 in. drop
total Depth:	26.5 feet		

Depth, ft	Field: Sample	Field: Blows / inch	Laboratory: Dry Density, pcf	Laboratory: Moisture Content, %	Compression Strength, psf	Recovery (%)	Pocket Pen, tsf	Symbol	Approx. Surface Elevation (ft): N/A **DESCRIPTION**
		1 2 2				100			Approx. 5 inches of concrete Brown, SILT to sandy SILT **(ML)**, race organics, Medium stiff, very moist **(Fill)**
		1 2 4				100			Becomces brown-gray SILT to clayey SILT **(ML)**, medium stiff, moist
5		3 6 8				100			Gray, sandy SILT **(ML)**/slightly silty SAND **(SM)**, stiff, moist
		1 5 7				100			Becomes brown SILT **(ML)**, stiff, moist
10		3 6 10				67			Gray, SILT/sandy SILT **(ML)**, very stiff, moist
		5 9 14				100			Gray, SILT/sandy SILT **(ML)**, very stiff, damp to moist, massive
15		6 10 17				100			
		4 5 6				89			Gray, SILT/clayey SILT **(ML)**, stiff, very moist to wet
20									

CASCADE GROUP INT LLC dba **CASCADE GEOTECHNW**	**LOG OF BORING B-1** **7431 E MERCER WAY**	**FIGURE** **A-1.1**
PROJECT # 2018-015 **11/27/2018**	**MERCER ISLAND, WASHINGTON**	

Date Started:	11/27/2018	Drill Rig:	Acker Portable Rig
Date Completed:	11/27/2018	Drilling Method:	4" Hollow Stem Auger
Logged by:	MX	Driving Energy:	140 lb. wt., 30 in. drop
total Depth:	26.5 feet		

	Field		Laboratory						Approx. Surface Elevation (ft): N/A
Depth, ft	Sample	Blows / inch	Dry Density, pcf	Moisture Content, %	Compression Strength, psf	Recovery (%)	Pocket Pen, tsf	Symbol	**DESCRIPTION**
20		2 6 10				100			Gray-brown, SILT/clayey SILT **(ML)**, very stiff, moist
25		9 12 16				100			Gray, SILT **(ML)**, very stiff, moist
									Boring terminated at about 26.5 feet. No groundwater encountered during drilling. Very moist to wet soil was observed from 17.5 to 20 feet.
30									
35									
20									

CASCADE GROUP INT LLC

dba **CASCADE GEOTECHNW**

PROJECT # 2018-015 **11/27/2018**

LOG OF BORING B-1

7431 E MERCER WAY

MERCER ISLAND, WASHINGTON

FIGURE A-1.2

Date Started:	11/27/2017	Drill Rig:	Acker Portable Rig
Date Completed:	11/27/2017	Drilling Method:	4" Hollow Stem Auger
Logged by:	MX	Driving Energy:	140 lb. wt., 30 in. drop
total Depth:	16.5 feet		

Depth, ft	Field: Sample	Field: Blows / inch	Laboratory: Dry Density, pcf	Laboratory: Moisture Content, %	Compression Strength, psf	Recovery (%)	Pocket Pen, tsl	Symbol	Approx. Surface Elevation (ft): N/A **DESCRIPTION**
		2 4 4				61			Approx. 4 inches of concrete Brown-gary, SILT **(ML)** with sand, trace gravel, medium stiff ti stiff, very moist **(Fill)**
		1 2 5				100			Becomes gray, SILT to clayey SILT **(ML)**, trace wood fragments, medium stiff, very moist
5		1 4 5				100			Brown, clayey SILT **(ML)**, minor oxide stains, stiff, moist
		2 4 5				100			Brown, SILTY/clayey SILT **(ML)**, stiff, moist
10		1 3 6				100			Gray, SILT **(ML)**, stiff, moist
15		4 7 10				100			Becomes gray, SILT **(ML)**, very stiff, moist
20									Boring terminated at about 16.5 feet. No groundwater encountered during drilling.

CASCADE GROUP INT LLC

dba **CASCADE GEOTECHNW**

PROJECT # 2018-015 **11/27/2018**

LOG OF BORING B-2

7431 E MERCER WAY

MERCER ISLAND, WASHINGTON

FIGURE A-2

KEY:

Indicates 3-inch OD Dames & Moore Sample.

Indicates 2-inch OD Split Spoon Sample (SPT).

Indicates Disturbed Sample.

Indicates No Recovery.

Indicates Bag Sample.

Indicates Shelby Tube Sample.

COMPONENT DEFINITIONS

COMPONENT	SIZE RANGE
Boulders	Larger than 12 in
Cobbles	3 in to 12 in
Gravel	3 in to No 4 (4.5mm)
Coarse gravel	3 in to 3/4 in
Fine gravel	3/4 in to No 4 (4.5mm)
Sand	No. 4 (4.5mm) to No. 200 (0.074mm)
Coarse sand	No. 4 (4.5 mm) to No. 10 (2.0 mm)
Medium sand	No. 10 (2.0 mm) to No. 40 (0.42 mm)
Fine sand	No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt and Clay	Smaller than No. 200 (0.074 mm)

COMPONENT PROPORTIONS

DESCRIPTIVE TERMS	RANGE OF PROPORTION
Trace or little	1 - 5%
Some	6 - 12%
Clayey, silty, sandy, gravelly	13 - 30%
And	31 - 50%

MOISTURE CONTENT

DRY	Absence of moisture, dusty, dry to the touch.
DAMP	Some perceptible moisture; below optimum
MOIST	No visible water; near optimum moisture content
WET	Visible free water, usually soil is below water table.

ATD: At Time of Drilling

BGS: Below Ground Surface

RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N -VALUE

COHESIONLESS SOILS			COHESIVE SOILS		
Density	N (blows/ft)	Approximate Relative Density (%)	Consistency	N (blows/ft)	Approximate Undrained Shear Strength (psf)
Very Loose	0 to 4	0 - 15	Very Soft	0 to 2	< 250
Loose	5 to 10	16 - 35	Soft	3 to 4	250 - 500
Medium Dense	11 to 30	36 - 65	Medium Stiff	5 to 8	501 - 1000
Dense	31 to 50	66 - 85	Stiff	9 to 15	1001 - 2000
Very Dense	over 50	86 - 100	Very Stiff	16 to 30	2001 - 4000
			Hard	over 30	> 4000

MAJOR DIVISION			GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS <u>LARGER</u> THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION <u>RETAINED</u> ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION <u>PASSING</u> NO. 4 SIEVE	CLEAN SAND (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS <u>SMALLER</u> THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT <u>LESS</u> THAN 50		ML	INORGANIC SILTS AND 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, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT <u>GREATER</u> THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

UNIFIED SOIL CLASSIFICATION SYSTEM