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Subsurface Exploration, Geologic Hazard, and Geotechnical Engineering Report

CHEN RESIDENCE

Mercer Island, Washington

Prepared For:

MR. HARVEY CHEN

Project No. 180261E001
September 20, 2018

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September 20, 2018
Project No. 180261E001

Mr. Harvey Chen
1542 24th Avenue NE
Issaquah, Washington 98029

Subject: Subsurface Exploration, Geologic Hazard,
and Geotechnical Engineering Report
Chen Residence
5024 West Mercer Way
Mercer Island, Washington

Dear Mr. Chen:

We are pleased to present the enclosed copies of our geotechnical report. This report summarizes the results of our subsurface exploration, geologic hazard, and geotechnical engineering studies and offers geotechnical recommendations for the design and development of the proposed project.

We have enjoyed working with you on this study and are confident that the recommendations presented in this report will aid in the successful completion of your project. Please contact me if you have any questions or if we can be of additional help to you.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

Bruce L. Blyton, P.E.
Senior Principal Engineer

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SUBSURFACE EXPLORATION, GEOLOGIC HAZARD, AND GEOTECHNICAL ENGINEERING REPORT

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I. PROJECT AND SITE CONDITIONS

1.0 INTRODUCTION

This report presents the results of our subsurface exploration, geologic hazards assessment, and geotechnical engineering study for the proposed residential project at the subject property. In the event that any changes in the nature, design, or layout of the project are planned, the conclusions and recommendations contained in this report should be reviewed and modified, or verified, as necessary.

1.1 Purpose and Scope

The purpose of this study was to provide subsurface soil and groundwater data to be utilized in the design of the subject project. Our study included reviewing available geologic literature, drilling three exploration borings, and performing a geologic study to assess the type, thickness, distribution, and physical properties of the subsurface sediments and shallow groundwater conditions. A geologic hazards assessment and geotechnical engineering studies were also completed to determine suitable geologic hazard mitigation techniques, the type of suitable foundations, allowable foundation soil bearing pressures, anticipated foundation settlements, erosion considerations, and drainage considerations. This report summarizes our current fieldwork and offers geologic hazard mitigation and preliminary development recommendations based on our present understanding of the project.

1.2 Authorization

Written authorization to proceed with this study was granted on July 16, 2018. Our study was accomplished in general accordance with our proposal, dated July 13, 2018. This report has been prepared for the exclusive use of Mr. Chen and his agents for specific application to this project. Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering and engineering geology practices in effect in this area at the time our report was prepared. No other warranty, express or implied, is made.

2.0 PROJECT AND SITE DESCRIPTION

The subject site is the undeveloped parcel located at 5024 West Mercer Way in Mercer Island, Washington (King County Parcel No. 1924059317) as shown on “Vicinity Map” (Figure 1). We understand that the current plan is to construct a new single-family residence at the subject site. Site topography is fairly level in the southeast portion and drops off steeply toward the northwest corner of the site with a total vertical relief of approximately 90 feet across the site. The property is moderately forested with various mature evergreen and deciduous trees. The site is bordered on all sides by residential properties. The subject site lies within Erosion and Potential Slide Critical Areas, and includes a Steep Slope Critical Area, as delineated in the City of Mercer Island maps.

For our use in preparing this report, we were provided with a topographic survey titled "Topographic Survey for Harvey Chen," prepared by Tyee Surveyors, dated May 29, 2018. We should be allowed to review our recommendations and make any revisions that may be required as project design moves forward.

3.0 SITE EXPLORATION

Our field study included drilling three exploration borings on August 28, 2018. The various types of sediments, as well as the depths where the characteristics of the sediments changed, are indicated on the exploration logs presented in the Appendix. The depths indicated on the logs where conditions changed may represent gradational variations between sediment types. If changes occurred between sample intervals in our exploration borings, they were interpreted. Our explorations were approximately located in the field by measuring from known site features and the above-referenced site plan. The site and the approximate locations of the subsurface explorations referenced in this study are presented on the "Site and Exploration Plan" (Figure 2).

The conclusions and recommendations presented in this report are based, in part, on the exploration borings completed for this study. The number, locations, and depths of the explorations were completed within site and budgetary constraints. Because of the nature of exploratory work below ground, extrapolation of subsurface conditions between field explorations is necessary. It should be noted that differing subsurface conditions may sometimes be present due to the random nature of deposition and the alteration of topography by past grading and/or filling. The nature and extent of variations between the field explorations may not become fully evident until construction. If variations are observed at that time, it may be necessary to re-evaluate specific recommendations in this report and make appropriate changes.

3.1 Exploration Borings

The borings were drilled using a limited-access, dolly-mounted, hollow-stem auger drill rig. During the drilling process, samples were generally obtained at 2½- to 5-foot-depth intervals. The borings were continuously observed and logged by a geologist from our firm. The exploration logs presented in the Appendix are based on the field logs, drilling action, and observation of the samples collected.

Disturbed but representative samples were obtained by using the Standard Penetration Test (SPT) procedure in accordance with *American Society for Testing and Materials* (ASTM) D-1586. This test and sampling method consists of driving a standard 2-inch, outside-diameter, split-barrel sampler a distance of 18 inches into the soil with a 140-pound hammer free-falling a distance of 30 inches. The number of blows for each 6-inch interval is recorded, and the number of blows required to drive the sampler the final 12 inches is known as the Standard Penetration Resistance ("N") or blow count. If a total of 50 is recorded within one 6-inch interval, the blow count is recorded as the number of blows for the corresponding number of inches of penetration. The resistance, or N-value, provides a measure of the relative density of granular soils or the relative consistency of cohesive soils; these values are plotted on the attached exploration boring logs.

The samples obtained from the split-barrel sampler were classified in the field and representative portions placed in watertight containers. The samples were then transported to our laboratory for further visual classification and laboratory testing, as necessary.

4.0 SUBSURFACE CONDITIONS

Subsurface conditions on the project site were inferred from the field explorations conducted for this study, visual reconnaissance of the site, and a review of applicable geologic literature. As shown on the exploration logs, soils encountered at the site consisted of surficial topsoil and Vashon advance outwash sediments. The deposits encountered at the site were generally consistent with those mapped in the site area on the *Geologic Map of Mercer Island, Washington,* compiled by K.G. Troost and A.P. Wisher, dated 2006. The published geologic map shows the project site mapped as Vashon advance outwash sediments with Vashon lodgement till sediments mapped nearby. The following section presents more detailed subsurface information on the sediment types encountered at the site.

4.1 Stratigraphy

Topsoil

A surficial layer of grass and organic topsoil was encountered at the surface of all of our exploration borings. This organic layer ranged from approximately 2 to 3 inches in thickness. Observed topsoil thickness is shown on the attached subsurface exploration logs. Due to their high organic content, these materials are not considered suitable for foundation, roadway, slab-on-grade floor support, or for use in a structural fill.

Vashon Advance Outwash

All of our exploration borings encountered sediments interpreted to be Vashon advance outwash beneath surficial topsoil. The outwash sediments consisted of material ranging from silty fine sand with trace gravel to fine sand with trace to some silt with trace gravel. The advance outwash sediments observed in our explorations graded from loose to medium dense and light brown in the weathered zone near the surface to medium dense to dense and light brownish gray with depth. Advance outwash was deposited by meltwater streams from an advancing glacier, and was subsequently compacted by the weight of the overlying glacial ice. Advance outwash is suitable for support of structural loads when prepared as recommended in this report. Some of the advance outwash onsite contains a significant fine-grained fraction and is sensitive to excess moisture during placement in structural fill applications. Reuse of advance outwash in structural fill applications will require drying to achieve moisture contents within 1 to 2 percent of optimum for compaction purposes.

4.2 Hydrology

Groundwater seepage was not encountered in the exploration borings completed for this study. It should be noted that the explorations performed for this study were completed during the seasonal time of low groundwater (August 2018). Groundwater conditions should be expected to vary in response to changes in season, weather, on- and off-site land use, and other factors.

II. GEOLOGIC HAZARDS AND MITIGATIONS

The following discussion of potential geologic hazards is based on the geologic, slope, and ground and surface water conditions, as observed and discussed herein.

5.0 SLOPE STABILITY ASSESSMENT

The City of Mercer Island geologic hazard maps indicate that the site is located in a steep slope hazard area. Therefore, the hazard must be addressed in the design of the foundation. The site's existing slopes are gently to moderately inclined within the proposed building pad, with a steep slope downward to the northwest and along the northern edge of the lot. The near-surface soil underlying the site consists primarily of loose grading to dense Vashon advance outwash sediments. We observed the site for indications of slope instability, such as bowed or tilted trees, naturally occurring terraced topography, tension cracks, reversed drainage gradients, and unvegetated soil exposures. We did not observe surface features that would indicate ongoing slope movement on the site or in the immediate vicinity.

It is our opinion that the risk of damage to the proposed structures by landsliding is low due to the presence of medium dense to dense, unsaturated soils observed at relatively shallow depths beneath the surface of the site and the lack of evidence of ongoing slope instability. No detailed slope stability analyses were completed as part of this study, and none are warranted, in our opinion. To the extent possible, we recommend that native vegetation be left on the slope to provide erosion control and that no fill material is placed atop or over the slope. As with all steep slopes, surface drainage should be properly controlled and directed away from sloping areas.

6.0 SEISMIC HAZARDS AND MITIGATIONS

Earthquakes occur regularly in the Puget Lowland. The majority of these events are small and are usually not felt by people. However, large earthquakes do occur, as evidenced by the 1949, 7.2-magnitude event; the 1965, 6.5-magnitude event; and the 2001, 6.8-magnitude event. The 1949 earthquake appears to have been the largest in this region during recorded history and was centered in the Olympia area. Evaluation of earthquake return rates indicates that an earthquake of the magnitude between 5.5 and 6.0 is likely within a given 20-year period.

Generally, there are four types of potential geologic hazards associated with large seismic events: 1) surficial ground rupture, 2) seismically induced landslides, 3) liquefaction, and 4) ground motion. The potential for each of these hazards to adversely impact the proposed project is discussed below.

6.1 Surficial Ground Rupture

Generally, the largest earthquakes that have occurred in the Puget Sound area are sub-crustal events with epicenters ranging from 50 to 70 kilometers in depth. Earthquakes that are generated at such depths usually do not result in fault rupture at the ground surface.

The site is located within the mapped limits of the Seattle Fault Zone. Studies by the U.S. Geological Survey (USGS) and others have provided evidence of surficial ground rupture along splays of the Seattle Fault. The recognition of this fault is relatively new and data pertaining to it are limited, with the studies still ongoing. According to the USGS studies, the latest movement of this fault was about 1,100 years ago when about 20 feet of surficial displacement took place. This displacement can presently be seen in the form of raised, wave-cut beach terraces along Alki Point in West Seattle and Restoration Point at the south end of Bainbridge Island.

The recurrence interval of movement along this fault system is still unknown, although it is hypothesized to be in excess of several thousand years. Due to the suspected long recurrence interval, the potential for surficial ground rupture is considered to be low during the expected life of the new addition, and no mitigation efforts beyond complying with the current (2015) *International Building Code* (IBC) are recommended.

6.2 Seismically Induced Landslides

It is our opinion that the risk of damage to the proposed structures by seismically induced landsliding is low due to the presence of medium dense to dense soils observed at depth beneath the surface of the site.

6.3 Liquefaction

Liquefaction is a process through which unconsolidated soil loses strength as a result of vibrations, such as those which occur during a seismic event. During normal conditions, the weight of the soil is supported by both grain-to-grain contacts and by the fluid pressure within the pore spaces of the soil below the water table. Extreme vibratory shaking can disrupt the grain-to-grain contact, increase the pore pressure, and result in a temporary decrease in soil shear strength. The soil is said to be liquefied when nearly all of the weight of the soil is supported by pore pressure alone. Liquefaction can result in deformation of the sediment and settlement of overlying structures. Areas most susceptible to liquefaction include those areas underlain by non-cohesive silt and sand with low relative densities, accompanied by a shallow water table.

The observed site soils were medium dense to dense and unsaturated and are thus not expected to be prone to liquefaction. A detailed liquefaction hazard analysis was not performed as part of this study, and none is warranted, in our opinion.

6.4 Ground Motion

Structural design of the building should follow 2015 IBC standards using Site Class "D" as defined in Table 20.3-1 of *American Society of Civil Engineers (ASCE) 7 – Minimum Design Loads for Buildings and Other Structures*.

7.0 EROSION HAZARDS AND MITIGATION

The sediments underlying the site generally contain sand and sand with silt and will be sensitive to erosion. In order to reduce the amount of sediment transported off the site during construction, the following recommendations should be followed.

1. Silt fencing should be placed around the lower perimeter of all cleared area(s). The fencing should be periodically inspected and maintained as necessary to ensure proper function.

2. To the extent possible, earthwork-related construction should proceed during the drier periods of the year and disturbed areas should be revegetated as soon as possible. Temporary erosion control measures should be maintained until permanent erosion control measures are established.

3. Areas stripped of vegetation during construction should be mulched and hydroseeded, replanted as soon as possible, or otherwise protected. During winter construction, hydroseeded areas should be covered with clear plastic to facilitate grass growth.

4. If excavated soils are to be stockpiled on the site for reuse, measures should be taken to reduce the potential for erosion from the stockpile. These could include, but are not limited to, covering the pile with plastic sheeting, the use of low stockpiles in flat areas, and the use of straw bales/silt fences around pile perimeters.

5. Interceptor swales with rock check dams should be constructed to divert stormwater from construction areas and to route collected stormwater to an appropriate discharge location.

6. A rock construction entrance should be provided to reduce the amount of sediment transported off-site on truck tires.

7. All stormwater from impermeable surfaces, including driveways and roofs, should be tightlined into approved facilities and not be directed onto or above steeply sloping areas.

8.0 STATEMENT OF RISK

For Section 19.07.020(E) of the Mercer Island *Unified Land Development Code* (ULDC), the City of Mercer Island requires a statement of risk by the geotechnical engineer. It is Associated Earth Sciences, Inc.'s (AESI's) opinion that the development practices proposed for the alteration would render the development as safe as if it were not located in a geologic hazard area, provided the recommendations in this report are followed.

III. DESIGN RECOMMENDATIONS

9.0 INTRODUCTION

It is our opinion that, from a geotechnical standpoint, the property is suitable for the proposed development provided the recommendations contained herein are properly followed. The site is underlain by medium dense to dense advance outwash sediments. Conventional spread footing foundations bearing on either the medium dense to dense natural glacial sediments or on structural fill placed over these sediments are capable of providing suitable building support.

10.0 SITE PREPARATION

Site preparation of building and paving areas should include removal of all grass, trees, brush, debris, and any other deleterious materials. Any existing fill should be removed. Where any existing loose fill or natural sediments are relatively free of organics and near their optimum moisture content for compaction, they can be segregated and considered for reuse as structural fill. As noted previously, portions of the Vashon advance outwash sediments encountered in our explorations are moisture-sensitive and may be difficult to reuse as structural fill. Erosion and surface water control should be established around the perimeter of the excavation to satisfy City of Mercer Island requirements.

10.1 Temporary Cut Slopes

In our opinion, stable construction slopes should be the responsibility of the contractor and should be determined during construction based on the conditions encountered at that time. For estimating purposes, however, we anticipate that temporary, unsupported cut slopes in undisturbed dense advance outwash sediments can be planned at a maximum slope of 1H:1V (Horizontal:Vertical). Temporary, unsupported cut slopes in the medium dense or weathered advance outwash can be planned at 1.5H:1V. Temporary cut slopes may need to be adjusted in the field at the time of construction based on the presence of groundwater. This should be determined in the field by the geotechnical engineer. As is typical with earthwork operations, some sloughing and raveling may occur, and cut slopes may have to be adjusted in the field. In addition, WISHA/OSHA regulations should be followed at all times. If steeper or deeper cuts are required, then temporary shoring may be necessary.

10.2 Site Disturbance

The on-site soils contain a variable percentage of fine-grained material, which makes them moisture-sensitive and subject to disturbance when wet. Most of the soils encountered in our explorations appear to be above their optimum moisture content for compaction at the time of our study. The contractor must use care during site preparation and excavation operations so that the underlying soils are not softened, particularly during wet weather conditions. If disturbance occurs in areas of conventional footings, the softened soils should be removed and the area brought to grade with clean, crushed rock fill or the footings should be extended deeper. Because of the moisture-sensitive nature of the soils, we anticipate that wet weather construction would significantly increase the earthwork costs over dry weather construction.

11.0 STRUCTURAL FILL

Structural fill may be necessary to establish desired grades or to backfill around foundations and utilities. All references to structural fill in this report refer to subgrade preparation, fill type, placement, and compaction of materials, as discussed in this section. If a percentage of compaction is specified under another section of this report, the value given in that section should be used.

After overexcavation/stripping has been performed to the satisfaction of the geotechnical engineer/engineering geologist, the upper 12 inches of exposed ground should be recompacted to a firm and unyielding condition. If the subgrade contains too much moisture, adequate recompaction may be difficult or impossible to obtain and should probably not be attempted. In lieu of recompaction, the area to receive fill should be blanketed with washed rock or quarry spalls to act as a capillary break between the new fill and the wet subgrade. Where the exposed ground remains soft and further overexcavation is impractical, placement of an engineering stabilization fabric may be necessary to prevent contamination of the free-draining layer by silt migration from below.

After stripping and subgrade preparation of the exposed ground is approved, or a free-draining rock course is laid, structural fill may be placed to attain desired grades. Structural fill is defined as non-organic soil, acceptable to the geotechnical engineer, placed in maximum 8-inch loose lifts, with each lift being compacted to 95 percent of the modified Proctor maximum density using ASTM D-1557 as the standard.

The contractor should note that any proposed fill soils must be evaluated by AESI prior to their use in fills. This would require that we have a sample of the material at least 3 business days in advance to perform a Proctor test and determine its field compaction standard. Soils in which the amount of fine-grained material (smaller than the No. 200 sieve) is greater than approximately 5 percent (measured on the minus No. 4 sieve size) should be considered moisture-sensitive. Use of moisture-sensitive soils in structural fills should be limited to favorable dry weather conditions. The on-site soils contain moderate amounts of silt and are considered moisture-sensitive. Therefore, they will not likely be suitable for use as structural fill under wet subgrade conditions. In addition, construction equipment traversing the site when the soils are wet can cause considerable disturbance. If fill is placed during wet weather, or if proper compaction cannot be obtained, a select on-site and/or import material consisting of a clean, free-draining gravel and/or sand should be used. Free-draining fill consists of non-organic soil with the amount of fine-grained material limited to 5 percent by weight when measured on the minus No. 4 sieve fraction and at least 25 percent greater than the No. 4 sieve.

A representative from our firm should inspect the stripped subgrade and be present during placement of structural fill to observe the work and perform a representative number of in-place density tests. In this way, the adequacy of the earthwork may be evaluated as filling progresses and any problem areas may be corrected at that time. It is important to understand that taking random compaction tests on a part-time basis will not assure uniformity or acceptable performance of a fill. As such, we are available to aid the owner in developing a suitable monitoring and testing frequency.

12.0 FOUNDATIONS

12.1 Allowable Soil Bearing Pressure

Spread footings may be used for building support when founded either directly on the medium dense to dense, natural glacial sediments, or on structural fill placed over these materials. Sediments suitable for foundation support in the area of the proposed building were encountered in our explorations at depths of approximately 2 to 5 feet, but may be locally deeper. For footings founded either directly upon the medium dense to dense glacial sediments, or on structural fill as described above, we recommend that an allowable bearing pressure of 2,500 pounds per square foot (psf) be used for design purposes, including both dead and live loads. We recommend that the footing subgrade be recompacted to a firm and unyielding condition prior to footing placement. An increase in the allowable bearing pressure of one-third may be used for short-term wind or seismic loading. If structural fill is placed below footing areas, the structural fill should extend horizontally beyond the footing edges a distance equal to or greater than the thickness of the fill.

12.2 Footing Depths

Perimeter footings for the proposed building should be buried a minimum of 18 inches into the surrounding soil for frost protection. No minimum burial depth is required for interior footings; however, all footings must penetrate to the prescribed stratum, and no footings should be founded in or above loose, organic, or existing fill soils.

12.3 Footings Adjacent to Cuts

The area bounded by lines extending downward at 1H:1V from any footing must not intersect another footing or intersect a filled area that has not been compacted to at least 95 percent of ASTM D-1557. In addition, a 1.5H:1V line extending down from any footing must not daylight because sloughing or raveling may eventually undermine the footing. Thus, footings should not be placed near the edges of steps or cuts in the bearing soils.

12.4 Footing Settlement

Anticipated settlement of footings founded as described above should be on the order of 1 inch or less. However, disturbed soil not removed from footing excavations prior to footing placement could result in increased settlements.

12.5 Footing Subgrade Bearing Verification

All footing areas should be observed by AESI prior to placing concrete to verify that the exposed soils can support the design foundation bearing capacity and that construction conforms with the recommendations in this report. Foundation bearing verification may also be required by the governing municipality.

12.6 Foundation Drainage

Perimeter footing drains should be provided as discussed under the "Drainage Considerations" section of this report.

13.0 LATERAL WALL PRESSURES

All backfill behind retaining walls or around foundation units should be placed as per our recommendations for structural fill and as described in this section of the report. Horizontally backfilled retaining walls that are free to yield laterally at least 0.1 percent of their height may be designed using an equivalent fluid equal to 35 pounds per cubic foot (pcf). Fully restrained, horizontally backfilled, rigid walls that cannot yield should be designed for an equivalent fluid of 50 pcf. If roadways, parking areas, or other areas subject to vehicular traffic are adjacent to retaining walls, a surcharge equivalent to 2 feet of soil should be added to the wall height in determining lateral design forces. Retaining walls that retain sloping backfill at a maximum angle of 2H:1V should be designed using an equivalent fluid pressure of 55 pcf for yielding conditions or 75 pcf for fully restrained conditions.

In accordance with the 2015 IBC, retaining wall design should include seismic design parameters. Based on the site soils and assumed wall backfill materials, we recommend a seismic surcharge pressure in addition to the equivalent fluid pressures presented above. A rectangular pressure distribution of 5H and 10H psf (where H is the height of the wall in feet) should be included in design for "active" and "at-rest" loading conditions, respectively. The resultant of the rectangular seismic surcharge should be applied at the midpoint of the walls.

The lateral pressures presented above are based on the conditions of a uniform horizontal backfill consisting of the on-site, natural, glacial sediments or imported sand and gravel compacted to 90 percent of ASTM D-1557. A higher degree of compaction is not recommended, as this will increase the pressure acting on the wall.

Footing drains must be provided for all retaining walls, as discussed under the "Drainage Considerations" section of this report. It is imperative that proper drainage be provided so that hydrostatic pressures do not develop against the walls. This would involve installation of a minimum, 1-foot-wide blanket drain to within 1 foot of the ground surface using imported, washed gravel against the walls placed to be continuous with the footing drain.

13.1 Passive Resistance and Friction Factors

Lateral loads can be resisted by friction between the foundation and the competent natural sediments or supporting structural fill soils, and/or by passive earth pressure acting on the buried portions of the foundations. The foundations must be backfilled with compacted structural fill to achieve the passive resistance provided below. We recommend the following allowable design parameters.

- Passive equivalent fluid = 300 pcf
- Coefficient of friction = 0.35

14.0 FLOOR SUPPORT

Slab-on-grade floors may be constructed either directly on the medium dense to dense natural sediments, or on structural fill placed over these materials. Areas of the slab subgrade that are disturbed (loosened) during construction should be recompacted to an unyielding condition prior to placing the pea gravel, as described below.

If moisture intrusion through slab-on-grade floors is to be limited, the floors should be constructed atop a capillary break consisting of a minimum thickness of 4 inches of washed pea gravel or washed crushed rock. The pea gravel/crushed rock should be overlain by a 10-mil (minimum thickness) plastic vapor retarder.

15.0 DRAINAGE CONSIDERATIONS

All retaining and perimeter footing walls should be provided with a drain at the footing elevation. Drains should consist of rigid, perforated, polyvinyl chloride (PVC) pipe surrounded by washed pea gravel or drain rock. The level of the perforations in the pipe should be set approximately 2 inches below the bottom of the footing and should be constructed with sufficient gradient to allow gravity discharge away from the structures.
In addition, all retaining walls should be lined with a minimum, 12-inch-thick, washed gravel blanket provided over the full height of the wall that ties into the footing drain. Roof and surface runoff should not discharge into the footing drain system, but should be handled by a separate, rigid, tightline drain. In planning, exterior grades adjacent to walls should be sloped downward away from the structure to achieve surface drainage. All collected runoff must be tightlined to a City-approved location.

16.0 PROJECT DESIGN AND CONSTRUCTION MONITORING

We recommend that AESI perform a geotechnical review of the plans prior to final design completion. In this way, our recommendations may be properly interpreted and implemented in the design. This plan review is not included in the current scope of work and budget.

We are also available to provide geotechnical engineering and monitoring services during construction. The integrity of the earthwork and foundations depends on proper site preparation and construction procedures. In addition, engineering decisions may have to be made in the field in the event that variations in subsurface conditions become apparent. Construction monitoring services are not part of this current scope of work.

We have enjoyed working with you on this study and are confident these recommendations will aid in the successful completion of your project. If you should have any questions or require further assistance, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

Tyler Gilsdorf

Tyler Gilsdorf, G.I.T., CESCL
Senior Staff Geologist

BRUCE L. BLYTON
26890
9/24/18

Jeffrey P. Laub, L.G., L.E.G.
Senior Engineering Geologist

Bruce L. Blyton, P.E.
Senior Principal Engineer

Attachments:	Figure 1:	Vicinity Map
	Figure 2:	Site and Exploration Plan
	Appendix:	Exploration Logs

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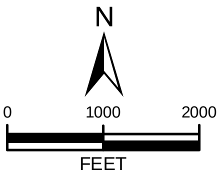

DATA SOURCES / REFERENCES:
USGS: 7.5' SERIES TOPOGRAPHIC MAPS, ESRI/I-CUBED/NGS 2013
KING CO: STREETS, CITY LIMITS 1/18, PARCELS 8/18

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

NOTE: BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

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VICINITY MAP

CHEN RESIDENCE
MERCER ISLAND, WASHINGTON

PROJ NO.	DATE:	FIGURE:
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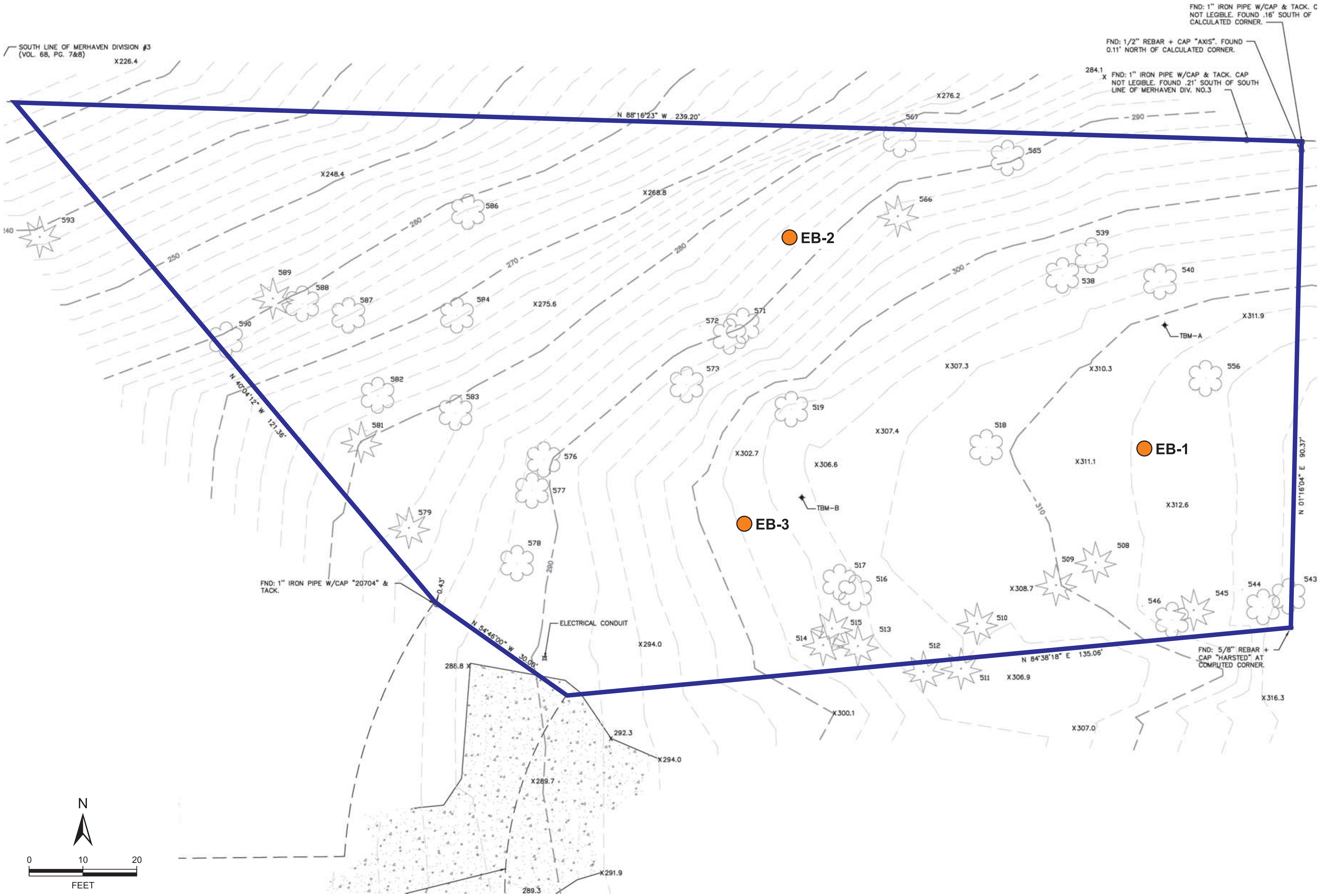

LEGEND:

● **EB** EXPLORATION BORING

▬ SITE BOUNDARY

CONTOUR INTERVAL = 2'

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE.

NOTES:

1. BASE MAP REFERENCE: TYEE SURVEYORS, 18080, TOPOGRAPHIC SURVEY FOR HARVEY CHEN, SHEET 1 OF 1, DATED 5/29/18.

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SITE AND EXPLORATION PLAN

CHEN RESIDENCE
MERCER ISLAND, WASHINGTON

PROJ NO.	DATE:	FIGURE:
180261E001	9/18	2

180261 Chen \ 180261E001 F2 S-E Plan.cdr

APPENDIX

Coarse-Grained Soils - More than 50%[1] Retained on No. 200 Sieve	Gravels - More than 50%[1] of Coarse Fraction Retained on No. 4 Sieve	≤5% Fines[5]	**GW**	Well-graded gravel and gravel with sand, little to no fines
			GP	Poorly-graded gravel and gravel with sand, little to no fines
		≥12% Fines[5]	**GM**	Silty gravel and silty gravel with sand
			GC	Clayey gravel and clayey gravel with sand
	Sands - 50%[1] or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines[5]	**SW**	Well-graded sand and sand with gravel, little to no fines
			SP	Poorly-graded sand and sand with gravel, little to no fines
		≥12% Fines[5]	**SM**	Silty sand and silty sand with gravel
			SC	Clayey sand and clayey sand with gravel
Fine-Grained Soils - 50%[1] or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50		**ML**	Silt, sandy silt, gravelly silt, silt with sand or gravel
			CL	Clay of low to medium plasticity; silty, sandy, or gravelly clay, lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		**MH**	Elastic silt, clayey silt, silt with micaceous or diatomaceous fine sand or silt
			CH	Clay of high plasticity, sandy or gravelly clay, fat clay with sand or gravel
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			**PT**	Peat, muck and other highly organic soils

Terms Describing Relative Density and Consistency

	Density	SPT[2] blows/foot
Coarse-Grained Soils	Very Loose	0 to 4
	Loose	4 to 10
	Medium Dense	10 to 30
	Dense	30 to 50
	Very Dense	>50
	Consistency	**SPT[2] blows/foot**
Fine-Grained Soils	Very Soft	0 to 2
	Soft	2 to 4
	Medium Stiff	4 to 8
	Stiff	8 to 15
	Very Stiff	15 to 30
	Hard	>30

Test Symbols

G = Grain Size
M = Moisture Content
A = Atterberg Limits
C = Chemical
DD = Dry Density
K = Permeability

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

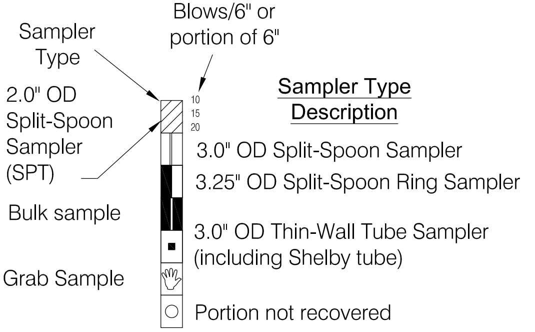
(3) Estimated Percentage

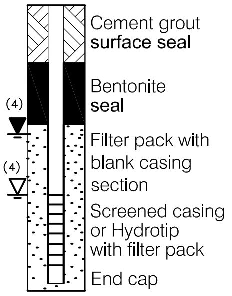
Component	Percentage by Weight
Trace	<5
Some	5 to <12
Modifier (silty, sandy, gravelly)	12 to <30
Very *modifier* (silty, sandy, gravelly)	30 to <50

Moisture Content

Dry - Absence of moisture, dusty, dry to the touch
Slightly Moist - Perceptible moisture
Moist - Damp but no visible water
Very Moist - Water visible but not free draining
Wet - Visible free water, usually from below water table

Symbols





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(1) Percentage by dry weight
(2) (SPT) Standard Penetration Test (ASTM D-1586)
(3) In General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)
(4) Depth of ground water
▼ ATD = At time of drilling
▽ Static water level (date)
(5) Combined USCS symbols used for fines between 5% and 12%

Classifications of soils in this report are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D-2487 and D-2488 were used as an identification guide for the Unified Soil Classification System.

blocks \ dwg \ log_key.dwg LAYOUT: Layout 4 -2014 Qty Chng

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EXPLORATION LOG KEY

FIGURE A1

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Exploration Log

Project Number	Exploration Number	Sheet
180261E001	EB-1	1 of 1

Project Name: Chen Residence
Location: Mercer Island, WA
Driller/Equipment: CN-Drilling / Acker
Hammer Weight/Drop: 140# / 30"
Ground Surface Elevation (ft): 312
Datum: NAVD 88
Date Start/Finish: 8/28/18,8/28/18
Hole Diameter (in): 6 inches

Samples	DESCRIPTION	Blows/6"	Blows/Foot
	Topsoil - 3 inches		
	Vashon Advance Outwash		
S-1	Slightly moist, light brown, fine to medium SAND, trace gravel, trace silt; faint stratification; minor weathering (SP). Harder drilling at 1.5 feet.	1 1 4	5
S-2	Slightly moist, light brown to light tan, fine to medium SAND, some silt, trace gravel; faint stratification; minor weathering (SP-SM).	6 8 11	19
S-3	Slightly moist, light brown to light tan, fine to medium SAND, trace silt, trace gravel; massive; minor weathering (SP).	7 9 11	20
S-4	Slightly moist, light brown to light brownish gray, silty, fine to medium SAND, trace gravel; layer (~1 inch thick) of very silty, fine sand (SP-SM).	6 10 11	21
S-5	Moist, light brownish gray, very silty, fine SAND ranging to sandy, SILT, trace gravel; stratified (SM-ML). Very hard drilling 11 to 12.5 feet. Driller added water at 11.5 to 12 feet to aid in drilling action.	6 7 8	15
S-6	Moist, light brownish gray, very silty, fine SAND; laminated silt (SM).	10 11 15	26

Bottom of exploration boring at 14 feet
No groundwater encountered.

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: TG
Approved by: JHS

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Exploration Log

Project Number	Exploration Number	Sheet
180261E001	EB-2	1 of 1

Project Name: Chen Residence
Location: Mercer Island, WA
Driller/Equipment: CN-Drilling / Acker
Hammer Weight/Drop: 140# / 30"
Ground Surface Elevation (ft): 286
Datum: NAVD 88
Date Start/Finish: 8/28/18,8/28/18
Hole Diameter (in): 6 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot 10 20 30 40	Other Tests
				Topsoil - 3 inches **Vashon Advance Outwash**					
		S-1		Dry to slightly moist, light brown to light brownish gray, fine SAND, some silt, trace gravel; no apparent structure; minor organics; minor weathering (SP-SM).			1 2 1	▲3	
		S-2		Slightly moist, light to dark brown, fine SAND, some silt, trace gravel; wood debris in sampler (SP-SM).			1 1 2	▲3	
5		S-3		Moist, light brown to light brownish gray, fine to medium SAND, some silt, trace gravel; massive (SP-SM). Harder drilling at ~6 to 10 feet.			6 8 9	▲17	
10		S-4		Moist, light brown to light brownish gray, silty, fine to medium SAND, trace gravel; stratified (SM).			5 9 11	▲20	
				Gravelly drilling at ~13 feet, driller added water at 13 feet to aid in drilling action.					
15		S-5		Moist, gray to brownish gray, fine to medium SAND, trace silt, trace gravel; faint stratification (SP).			6 14 15	▲29	
20		S-6		As above.			8 15 19	▲34	
				Bottom of exploration boring at 21.5 feet No groundwater encountered.					
25									

Sampler Type (ST):

▯ 2" OD Split Spoon Sampler (SPT)	☐ No Recovery	M - Moisture
▯ 3" OD Split Spoon Sampler (D & M)	◧ Ring Sample	▽ Water Level ()
✋ Grab Sample	▨ Shelby Tube Sample	▼ Water Level at time of drilling (ATD)

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Exploration Log

Project Number	Exploration Number	Sheet
180261E001	EB-3	1 of 1

Project Name Chen Residence
Location Mercer Island, WA
Driller/Equipment CN-Drilling / Acker
Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) 302
Datum NAVD 88
Date Start/Finish 8/28/18,8/28/18
Hole Diameter (in) 6 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot 10 20 30 40	Other Tests
				Topsoil - 2 inches					
		S-1		**Vashon Advance Outwash** Slightly moist, light brown to light brownish gray, fine to medium SAND, some silt, trace gravel; minor organics (SP-SM).			2 2 4	▲6	
		S-2		Slightly moist, light brown, silty, fine SAND, trace gravel; faint stratification; minor organics (SM).			1 2 5	▲7	
5		S-3		Harder drilling at ~4.5 feet. Moist, light brown to light brownish gray, silty, fine to medium SAND, trace gravel; stratified; lens (~1 to 2 inches thick) of silt (SM).			8 13 15	▲28	
		S-4		Moist, light brown to brownish gray, fine to medium SAND, some silt, trace gravel (SP-SM).			10 14 21	▲35	
10				Bottom of exploration boring at 9 feet No groundwater encountered.					
15									
20									
25									

Sampler Type (ST):

▯ 2" OD Split Spoon Sampler (SPT)	☐ No Recovery	M - Moisture
▯ 3" OD Split Spoon Sampler (D & M)	◧ Ring Sample	∇ Water Level ()
☐ Grab Sample	▨ Shelby Tube Sample	▼ Water Level at time of drilling (ATD)

Logged by: TG
Approved by: JHS