Ages Engineering, LLC

A Geotechnical & Environmental Services LLC

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March 23, 2017
Project No. A-1328

Warren and Nancy Appleton
P. O. Box 1532
Mercer Island, WA. 98040

Subject: Geotechnical Evaluation
Appleton Residence
2742 – 71st Avenue SE
Mercer Island, Washington
Parcel Number: 2174501880

Dear Warren and Nancy,

As requested, we have completed a geotechnical evaluation of the soil and groundwater conditions at the subject site located at 2742 – 71st Avenue SE in Mercer Island, Washington. The location of the site is shown on the Site Vicinity Map provided in Figure 1.

We were provided with one sheet of preliminary site drawings. Our understanding of the project is based on our review of the plan provided to us and our conversations with the project contractor. We understand the existing residence on the site will be remodeled. The first phase of the planned remodel will be to stabilize the foundations. Currently, the foundations along the portions of the existing structure have settled. To stabilize the foundations and allow for the planned remodel, pin piles will be utilized. The preliminary plans show piles will be used along the northern foundation line, the carport along the western end of the residence, and the deck along the eastern end of the existing residence.

The conclusions and recommendations presented in this report are based on our understanding of the above stated site and the planned project design features. If actual site conditions differ, the planned project design features are different than we expect, or if changes are made, we should review them in order to modify or supplement our conclusions and recommendations as necessary.

SCOPE OF WORK

The purpose of our service was to perform a geotechnical evaluation of the site soil and groundwater conditions to develop design and construction recommendations for the new foundation support planned on the site. Specifically, the scope of services for this Geotechnical Evaluation included the following:

- Reviewing the available geologic, hydrogeologic and geotechnical data for the site area, and conducting a geologic reconnaissance of the site area.
- Addressing the appropriate geotechnical regulatory requirements for the planned site development, including a Geologic Hazard evaluation.
- Advancing two test holes in the planned new development area to a maximum depth of 7.0 feet below surface grades.
- Providing geotechnical recommendations for design and construction of pin piles for use in alternate foundation support, including allowable bearing capacity and estimates of settlement.
- Providing recommendations for site drainage.

SITE CONDITIONS

Surface

The subject site is a residential lot located at 2742 – 71st Avenue SE in Mercer Island, Washington. The subject site is currently occupied with a single-family residence located in the center of the site. The site is bordered with single-family residential parcels to the north, south, and east, and 71st Avenue SE to the west. Site access will be provided from 71st Avenue SE along the west side of the site. The location of the site is shown on the Site Vicinity Map provided in Figure 1.

Surface grades in the vicinity of the site slope down to the north at an approximate 8 percent grade. Site vegetation consists of typical landscape bushes and trees around the residence.

Mapped Soils

The Geologic Map of Mercer Island, Washington by Kathy G. Troost and Aaron P. Wisher, (October 2006) maps the soil in the vicinity of the site as Glacial Till (Qva). The Advance Outwash was deposited during the Vashon stade of the Fraser Glaciation, approximately 12,000 to 15,000 years ago. The Advance Outwash was deposited in front of the advancing glacial ice during brief periods of warming and was consequently over-ridden by the glacial ice mass. The Advance Outwash is a mixture of sand and gravel with minor silt and cobble content. The Advance Outwash will typically be found in a dense condition where undisturbed. The near surface soils at the site have been disturbed by natural weathering processes that have occurred since their deposition. No springs or groundwater seepage was observed on the surface of the site at the time of our site visit. A copy of the Geologic Map for the subject site is provided in Figure 3.

The United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) maps the soils in the vicinity of the site as Arents, Alderwood material (AmC) soils that form on 6 to 15 percent slopes. According to the NRCS the Arents, Alderwood soils at the site are described as glacial till deposits and are classified as having a "moderate" potential for erosion when exposed. A copy of the USDA NRCS map for the subject site is provided in Figure 4.

Site Explorations

On March 22, 2017, a representative from our office was on site to explore subsurface conditions at the site by advancing two hand-augured test holes to a maximum depth of 7.0 feet below existing surface grades. The approximate Test Hole locations are shown on the Exploration Location Plan provided in Figure 2.

Our representative continuously monitored the excavations, maintained logs of the subsurface conditions encountered in each test hole, obtained representative soil samples, and observed pertinent site features. The specific number, location, and depth of the explorations were selected by Ages Engineering, LLC personnel in the field. The soils encountered were visually classified in accordance with the Unified Soil Classification System (USCS) provided in Figure 5. The explorations performed as part of this evaluation indicate subsurface conditions at specific locations only and actual subsurface conditions can vary across the site. Furthermore, the nature and extent of any such variation may not become evident until additional explorations are performed or construction activities begin. The test hole logs are provided in Figure 6.

Representative soil samples obtained from the test holes were placed in sealed containers and taken to a laboratory for further examination and testing. The moisture content of the soils obtained during our exploration were determined and are presented on the test hole logs.

Site Soils

In general, the soils we observed underlying the site during our site explorations varied slightly from the mapped stratigraphy of the site area. The site is underlain old fill soils overlying a thin layer of native silty sand with gravel consistent with weathered Glacial Till and sand with silt and gravel consistent with Advance Outwash.

In both of the test holes advanced on the site, we encountered 3.0 feet of old fill soils in the upper portions of the test holes. The old fill consisted of loose topsoil overlying very loose sand with silt. Below 3.0 feet we encountered loose to medium dense, moist silty sand with gravel consistent with weathered glacial till to a depth of 5.0 feet below surface grades. Below 5.0 feet, the soils became moist, medium dense sand with silt and ravel consistent with Advance Outwash. Both of the test holes were terminated in the native Advance Outwash soils. Both of the test holes were terminated in the native light brown glacial till. The test hole logs are provided in Figure 6.

Groundwater

We did not encounter groundwater seepage in either of the test holes advanced on the site. We expect a seasonal perched water table develops under the site at times during the wet winter season. Perched groundwater levels and flow rates will fluctuate seasonally and typically reach their highest levels during and shortly following the wet winter months (October through May).

GEOLOGIC HAZARDS

General

According to Section 19.16 in the City of Mercer Island Municipal Code, geologic hazard areas are defined as "Areas susceptible to erosion, sliding, earthquake, or other geological events based on a combination of slope (gradient or aspect), soils, geologic material, hydrology, vegetation, or alterations, including landslide hazard areas, erosion hazard areas and seismic hazard areas".

Landslide

According to Section 19.16 in the City of Mercer Island municipal code, Landslide Hazard Areas are defined as, "Those areas subject to landslides based on a combination of geologic, topographic, and hydrologic factors, including:

1. Areas of historic failures;
2. Areas with all three of the following characteristics:
    a. Slopes steeper than 15 percent; and
    b. Hillsides intersecting geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock; and
    c. Springs or ground water seepage;
3. Areas that have shown evidence of past movement or that are underlain or covered by mass wastage debris from past movements;
4. Areas potentially unstable because of rapid stream incision and stream bank erosion; or
5. Steep Slope. Any slope of 40 percent or greater calculated by measuring the vertical rise over any 30-foot horizontal run."

During our site visit and subsurface exploration, we did not observe any evidence of past site movement or areas of historic failures. We did not observe any areas of rapid stream incision or any areas sloping 40 percent or greater. We did not observe slopes steeper than 15 percent on the site. Based on these factors, according to the city of Mercer Island municipal code, the site is not classified as having landslide hazard areas.

Erosion

According to Section 19.16 in the City of Mercer Island municipal code, Erosion Hazard areas are defined as, "Those areas greater than 15 percent slope and subject to a severe risk of erosion due to wind, rain, water, slope and other natural agents including those soil types and/or areas identified by the U.S. Department of Agriculture's Natural Resources Conservation Service as having a "severe" or "very severe" rill and inter-rill erosion hazard."

The site does not have any areas sloping steeper than 15 percent. Based on our subsurface exploration, the site is underlain with soils having a "moderate" potential for erosion when exposed. Therefore, according to the City of Mercer Island municipal code, the site is not classified as having erosion hazard areas.

In our opinion, regardless of the erosion hazard classification at the site, Temporary Erosion and Sediment Control (TESC) measures should be in place prior to the start of construction activities at the site. In our opinion, the potential for erosion is not a limiting factor in site development. Erosion hazards can be mitigated by applying Best Management Practices (BMPs) outlined in the Washington State Department of Ecology's (Ecology) *Stormwater Management Manual for Western Washington.* TESC measures, as required by the City of Mercer Island, should be in place prior to the start of construction activities at the site.

Seismic

According to Section 19.16 in the City of Mercer Island municipal code, seismic hazard areas are defined as, "areas subject to severe risk of damage as a result of earthquake induced ground shaking, slope failure, settlement, soil liquefaction or surface faulting."

We observed no site features indicating past seismic disturbance. We did not find any published information during our research of the site indicating the site is located in a seismically sensitive area. Structures constructed on this site using the seismic criteria provided in the City of Mercer Island municipal code and the International Building Code (IBC) will have no greater chance of seismic damage during an earthquake than any other residential structure in the Puget Sound area.

Liquefaction is a phenomenon where there is a reduction or complete loss of soil strength due to an increase in pore water pressure. The increase in water pressure is typically induced by vibrations such as those associated with earthquakes. Liquefaction mainly affects geologically recent deposits of loose, fine-grained sands that are below the groundwater table. Due to the site being underlain with glacially consolidated till soils that are in a medium dense to dense condition, it is our opinion, the liquefaction potential of the site should be considered very low.

The state of Washington has adopted the International Building Code (IBC). Based on the soil conditions encountered and the local geology, site class "C" can be used in structural design. This correlates to Soil Profile Type S_C in the Uniform Building Code (UBC). This is based on the inferred range of SPT (Standard Penetration Test) blow counts for the upper 100 feet of the site relative to hand excavation progress and probing with a ½-inch diameter steel probe rod. The presence of glacially consolidated soil conditions were assumed to be representative for the site conditions beyond the depths explored.

DISSCUSSION AND RECOMMENDATIONS

Based on our study, in our opinion, soil and groundwater conditions at the site are suitable for the proposed development. The existing foundations can be provided with additional support and stabilized by utilizing pin piles.

The native soils encountered at the site contain a high enough percentage of fines (silt and clay-size particles) that will make them difficult to compact as structural fill when too wet. Accordingly, the ability to use the soils from site excavations as structural fill will depend on their moisture content and the prevailing weather conditions at the time of construction. If grading activities will take place during the

winter season, the owner should be prepared to import free-draining granular material for use as structural fill and backfill.

The following sections provide detailed recommendations regarding these issues and other geotechnical design considerations. These recommendations should be incorporated into the final design drawings and construction specifications.

Supplemental Residential Foundation Support

Based on our study, in our opinion, soil and groundwater conditions at the site are suitable for the use of driven hollow steel pipe piles to provide additional foundation support for the existing residential foundations located on the site.

Based on the depth of fill, and the consistency and geologic nature of the native soils underlying the site, we recommend utilizing 2-inch diameter Pin Piles. Pin Piles larger than 2 inches in diameter can be utilized, however they will typically require load testing prior to installation, and performance testing during installation. Therefore, to prevent the potential for load testing and proof testing piles during construction, we recommend using 2-inch diameter Pin Piles.

Small diameter steel pipe piles are commonly referred to as Pin Piles, due to their relatively thin profile in relation to their long length. Very little site or subgrade preparation is necessary when supporting a foundation on Pin Piles. Pin Piles are hollow steel pipes that are mechanically driven into the ground along the outside of the existing foundation line with either a pneumatic device that essentially vibrates the pipe into the ground, or by a pneumatic hammer that successively pounds the pile into the ground. The piles are driven until their progress slows down to a pre-determined rate that is based on the pile size and pile driving mechanism. After installation, the piles are capped and connected to the existing foundation with either a steel anchor, or additional rebar and concrete. Pin Piles require a minimum embedment depth of at least 10 feet to achieve their design capacities. Due to the existence of loose native soils underlying the development area, we expect pile embedment depths of up to 25 feet will be necessary.

The structural engineer should be contacted to provide the exact pile diameter, location, number, and spacing, and to determine how many and where the battered piles, if any, will be necessary. With the anticipated building loads, we expect building settlements will be negligible. The allowable pile capacities for each pile size are provided in the following table.

Pin Pile Options		
Pile Diameter (inches)	**Pile Type**	**Pile Capacity (kips)**
2	Schedule 80 Steel	4
3	Schedule 40 Steel	12
4	Schedule 40 Steel	20

ADDITIONAL SERVICES

Ages Engineering, LLC should review the final project designs and specifications in order to verify that earthwork and foundation recommendations have been properly interpreted and incorporated into project design. If changes are made in the loads, grades, locations, configurations or types of facilities to be constructed, the conclusions and recommendations presented in this report may not be fully applicable. If such changes are made, we should be given the opportunity to review our recommendations and provide written modifications or verifications, as necessary.

We should also provide geotechnical services during construction to observe compliance with our design concepts, specifications, and recommendations. This will allow for expedient design changes if subsurface conditions differ from those anticipated prior to the start of construction.

LIMITATIONS

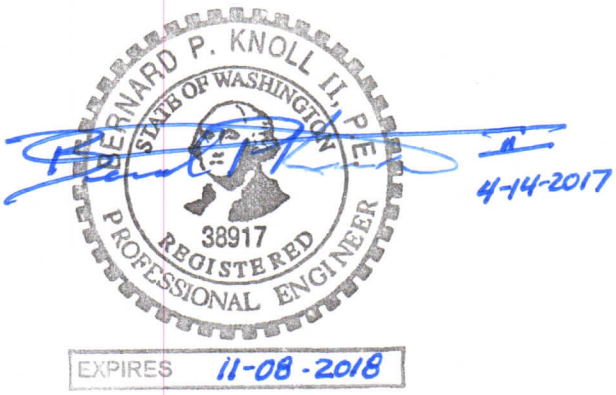
We prepared this report in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made. This report is the copyrighted property of Ages Engineering, LLC and is intended for the exclusive use of Warren and Nancy Appleton and their authorized representatives for use in the design, permitting, and construction portions of this project.

The analysis and recommendations presented in this report are based on data obtained from others and our site explorations, and should not be construed as a warranty of the subsurface conditions. Variations in subsurface conditions are possible. The nature and extent of which may not become evident until development continues. If variations appear evident, Ages Engineering, LLC should be requested to reevaluate the recommendations in this report prior to proceeding with construction. A contingency for unanticipated subsurface conditions should be included in the budget and schedule. Sufficient monitoring, testing and consultation should be provided by our firm during construction to confirm that the conditions encountered are consistent with those indicated during our exploration, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork and foundation installation activities comply with contract plans and specifications.

The scope of our services does not include services related to environmental remediation and construction safety precautions. Our recommendations are not intended to direct the contractor's methods, techniques, sequences or procedures, except as specifically described in our report for consideration in design.

We trust this information is sufficient for your current needs. If you have any questions, or require additional information, please call.

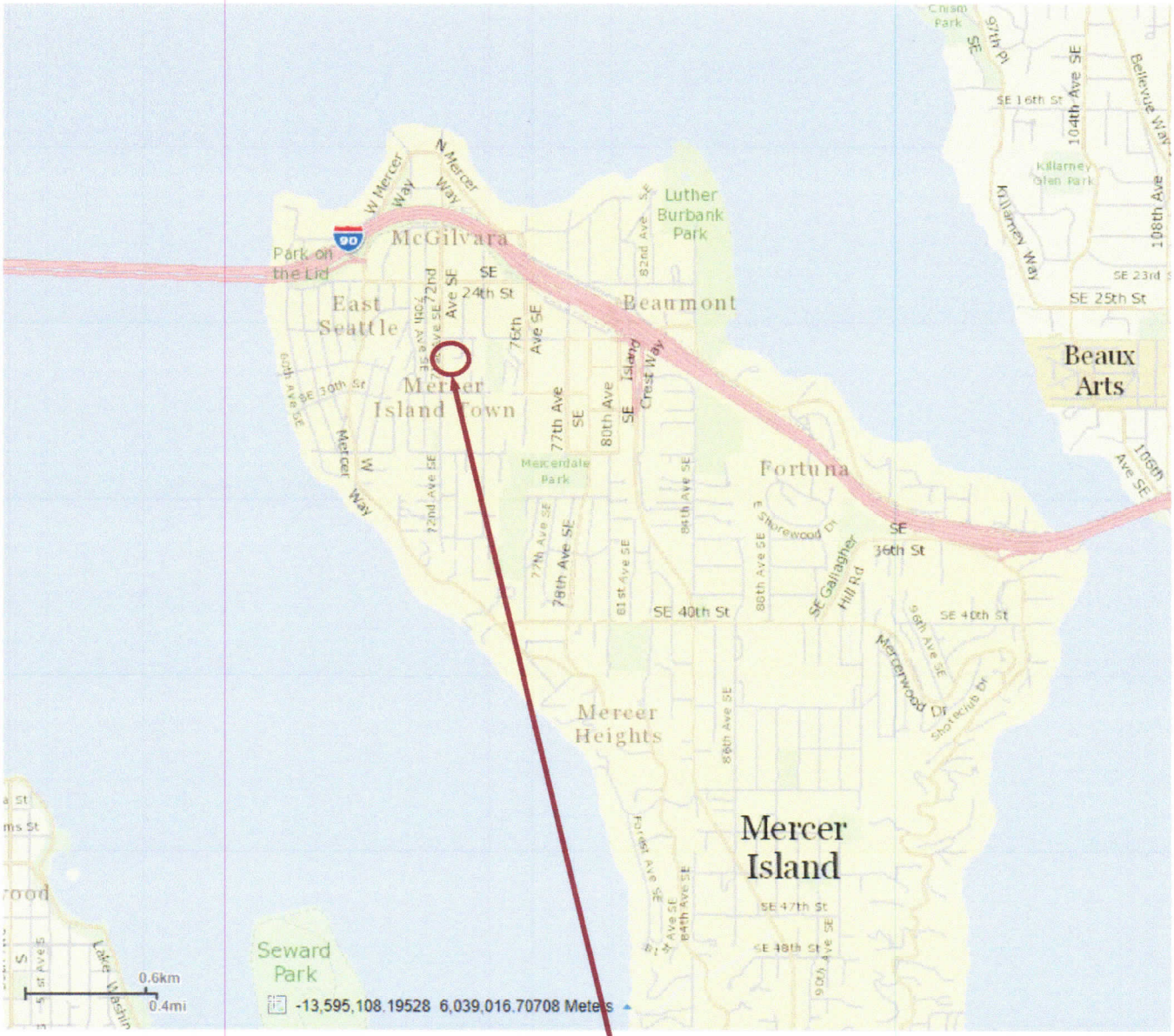
Respectfully Submitted,
Ages Engineering, LLC



Bernard P. Knoll, II, P.E.
Principal

BPK:bpk
Project No.: A-1328

ATTACHMENTS: Figure 1 – Site Vicinity Map
Figure 2 – Exploration Location Plan
Figure 3 – Geologic Map
Figure 4 – USDA NRCS
Figure 5 – USCS
Figure 6 - Test Hole Logs



Approximate Site Location

Ages Engineering, LLC
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Site Vicinity Map
Appleton Residence
2742 – 71st Avenue SE
Mercer Island, Washington

Project No.: A-1328	March 2017	**Figure 1**

KEY:

APPROXIMATE LOCATION OF TEST HOLE TH-1

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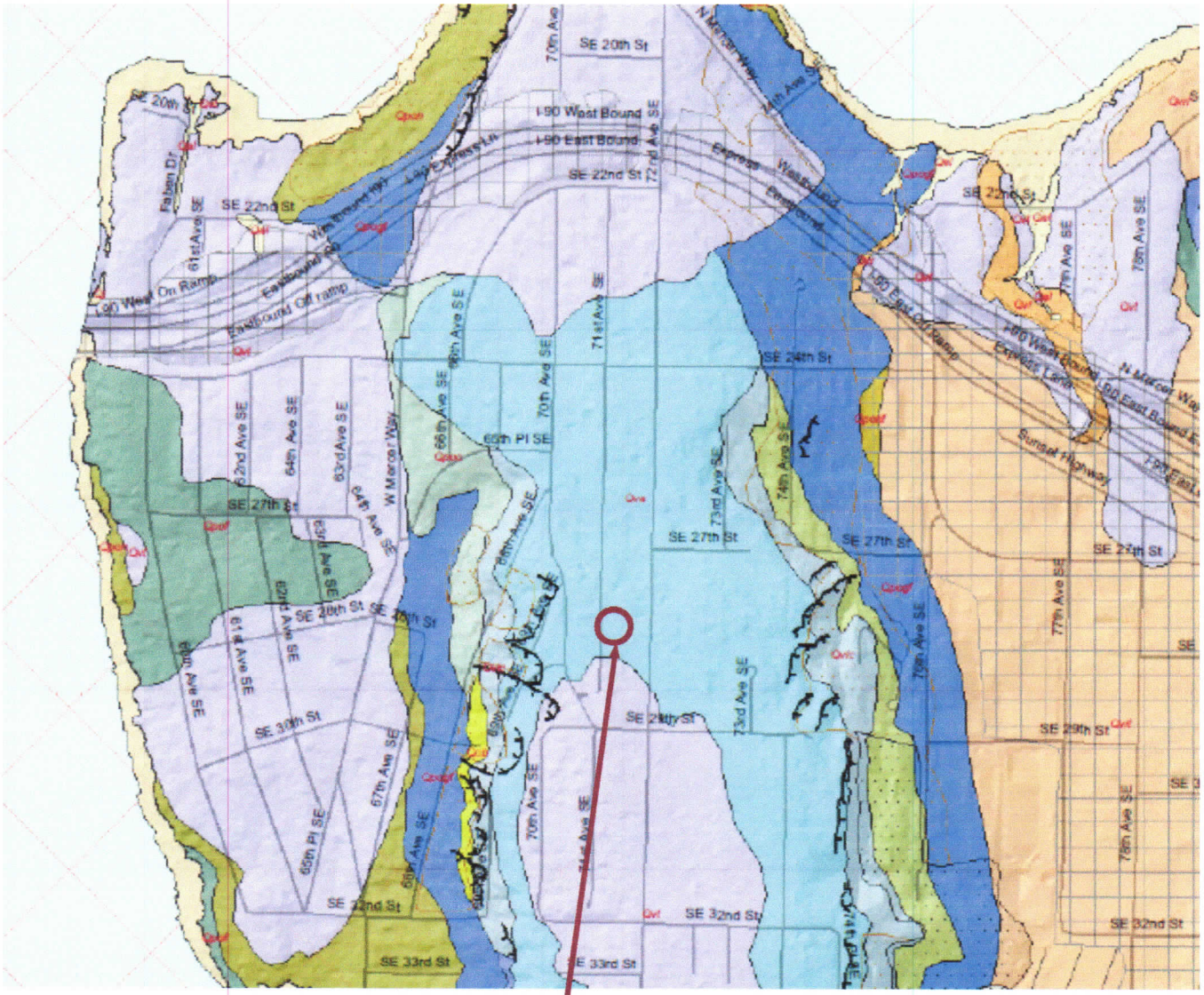
Exploration Location Plan
Appleton Residence
2742 – 71st Avenue SE
Mercer Island, Washington

Project No.: A-1328	March 2017	**Figure 2**



Approximate Site Location

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Geologic Map
Appleton Residence
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Project No.: A-1328	March 2017	**Figure 3**

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USDA NRCS Map
Appleton Residence
2742 – 71st Avenue SE
Mercer Island, Washington

Project No.: A-1328	March 2017	**Figure 4**

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE GRAINED SOILS More than 50% Retained on No. 200 Sieve	GRAVEL More than 50% Of Coarse Fraction Retained on No. 4 Sieve	GRAVEL WITH < 5 % FINES	GW	Well-Graded GRAVEL
			GP	Poorly-Graded GRAVEL
		GRAVEL WITH BETWEEN 5 AND 15 % FINES	GW-GM	Well-Graded GRAVEL with silt
			GW-GC	Well-Graded GRAVEL with clay
			GP-GM	Poorly-Graded GRAVEL with silt
			GP-GC	Poorly-Graded GRAVEL with clay
		GRAVEL WITH > 15 % FINES	GM	Silty GRAVEL
			GC	Clayey GRAVEL
	SAND More than 50% Of Coarse Fraction Passes No. 4 Sieve	SAND WITH < 5 % FINES	SW	Well-Graded SAND
			SP	Poorly-Graded SAND
		SAND WITH BETWEEN 5 AND 15 % FINES	SW-SM	Well-Graded SAND with silt
			SW-SC	Well-Graded SAND with clay
			SP-SM	Poorly-Graded SAND with silt
			SP-SC	Poorly-Graded SAND with clay
		SAND WITH > 15 % FINES	SM	Silty SAND
			SC	Clayey SAND
FINE GRAINED SOILS More than 50% Passes No. 200 Sieve	SILT AND CLAY	Liquid Limit Less than 50	ML	Inorganic SILT with low plasticity
			CL	Lean inorganic CLAY with low plasticity
			OL	Organic SILT with low plasticity
		Liquid Limit 50 or more	MH	Elastic inorganic SILT with moderate to high plasticity
			CH	Fat inorganic CLAY with moderate to high plasticity
			OH	Organic SILT or CLAY with moderate to high plasticity
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

(1) Soil descriptions are based on visual field and laboratory observations using the classification methods described in ASTM D-2488. Where laboratory data are available, classifications are in accordance with ASTM D-2487.

(2) Solid lines between soil descriptions indicate a change in the interpreted geologic unit. Dashed lines indicate stratigraphic change within the unit.

(3) Fines are material passing the U.S. No. 200 Sieve.

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Unified Soil Classification System (USCS)
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Project No.: A-1328	March 2017	**Figure 5**

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Test Hole TH-1

DATE: March 22, 2017 LOGGED BY: BPK ELEV:

Depth (feet)	Soil Description	Notes M%	Notes Other
0	**FILL:** Silty sand, Topsoil, burnt woody debris, moist, loose.		
	FILL: Reddish orange and tan sand with silt, moist, very loose.		
	Reddish-orange silty **SAND** with gravel, moist medium dense. (SM) (Weathered Glacial Till)		
5	Grayish tan **SAND** with silt and gravel, moist, medium dense. (SP-SM) (Weathered Advane Outwash)		
	Test Hole terminated at 7.0 feet below surface grades.		
	No groundwater seepage encountered.		

Test Hole TH-2

DATE: March 22, 2017 LOGGED BY: BPK ELEV:

Depth (feet)	Soil Description	Notes M%	Notes Other
0	**FILL:** Silty sand, Topsoil, burnt woody debris, moist, loose.		
	FILL: Reddish orange and tan sand with silt, moist, very loose.		
	Reddish-orange silty **SAND** with gravel, moist medium dense. (SM) (Weathered Glacial Till)		
5	Grayish tan **SAND** with silt and gravel, moist, medium dense. (SP-SM) (Weathered Advane Outwash)		
	Test Hole terminated at 7.0 feet below surface grades.		
	No groundwater seepage encountered.		

Figure 6

Project No.: A-1328