Ages Engineering

A Geotechnical Engineering Services Company

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GEOTECHNICAL REPORT

Ramaiyah Residence

7466 E. Mercer Way
Mercer Island, Washington
Parcel Number: 2579500136

Project No. A-1562-1

Prepared For:

Sella Ramaiyah
7466 E. Mercer Way
Mercer Island, Washington 98040

September 4, 2024

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Sella Ramaiyah
7466 E. Mercer Way.
Mercer Island, WA. 98040

Subject: Geotechnical Report
Ramaiyah Residence
7466 E. Mercer Way
Mercer Island, Washington
PN: 2579500136

Dear Ms. Ramaiyah,

As requested, we have conducted a geotechnical study for the subject project. The attached report presents our findings and recommendations for the geotechnical aspects of project design and construction.

Our field exploration indicates the site is generally underlain with 0.0 to 5.0 feet of old fill soils overlying Mass Wastage consisting of medium dense to dense, Advance Outwash-like, sand with silt and gravel and dense to very dense, Glacial Till-like, silty sand with gravel. We did not observe groundwater seepage to the depths explored.

In our opinion, the soil and groundwater conditions at the site are suitable for the planned development. The new structure can be supported on typical spread footing foundations bearing on a re-compacted surface of the existing organic-free undisturbed native soils observed at 0.0 to 5.0 feet below surface grades, or on structural fill placed above these soils.

Detailed recommendations addressing these issues and other geotechnical design considerations are presented in the attached report. We trust the information presented is sufficient for your current needs. If you have any questions or require additional information, please call.

Respectfully Submitted,

Ages Engineering

9-4-2024

Bernard P. Knoll, II
Principal

BPK:bpk

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Ramaiyah Residence
7466 E. Mercer Way
Mercer Island, Washington

1.0 PROJECT DESCRIPTION

The project will consist of a new single-family residence. The new structure will be a two-story wood framed structure with a daylight basement facing the east. The basement will have a slab-on-grade floor. The new residence will have an attached garage with slab-on-grade floors. Access to the site is provided by a shared driveway that extends to the site from East Mercer Way located to the west of the site. Storm water collected on the site will discharge to the existing storm water system located adjacent the site.

We understand the new residence will be a two-story wood-framed structure with daylight basement. The basement with attached garage will have slab-on-grade floors. Foundation loads will be relatively light, in the range of 1 to 3 kips per lineal foot for bearing walls and up to 25 kips for isolated column footings.

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.

2.0 SCOPE

On June 29, 2020, we excavated four hand-augured test holes to a maximum depth of 7.0 feet below surface grades. Using the information obtained from our subsurface exploration, we developed geotechnical design and construction recommendations for the project. Specifically, this report addresses 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 four test holes in the planned new development area to a maximum depth of approximately 7.0 feet below surface grades.
- Providing geotechnical recommendations for site grading including site preparation, subgrade preparation, fill placement criteria, suitability of on-site soils for use as structural fill, temporary and permanent cut and fill slopes, and drainage and erosion control measures.

- Providing geotechnical recommendations for design and construction of new foundations and floor slabs, including allowable bearing capacity and estimates of settlement.
- Providing geotechnical recommendations for lower-level building or retaining walls, including backfill and drainage requirements, lateral design loads, and lateral resistance values.
- Providing an evaluation of the steep slopes on the site.
- Providing recommendations for site drainage.

It should be noted that our work does not include services related to environmental remediation or design and performance issues related to moisture intrusion through walls. An appropriate design professional or qualified contractor should be contacted to address these issues. Our work does not include infiltration testing.

3.0 SITE CONDITIONS

3.1 Surface

The subject site area is an irregular shaped residential parcel located at 7466 East Mercer Way in the Clarke Beach area of Mercer Island, Washington. The subject site is currently occupied with a single-family residence located in the eastern central (downhill) portion of the site. A detached garage is located along the sites' eastern property line. A driveway switchbacks down the western end of the site to the detached garage located along the east end of the site. The site is bordered with residential lots to the north, east, and south, and by East Mercer Way to the west. The location of the site is shown on the Site Vicinity Map provided in Figure 1. The current site layout is shown on the Exploration Location Plan provided in Figure 2.

Groundwater seepage was observed emanating from the center of the sites' southern property line. The water is currently allowed to flow freely over the property line to a concrete collection basin constructed in the ground. The collected water then flows into a storm water pipe. The concrete collection basin is located in a flat area along the south side of the existing residence. A concrete retaining wall facing east with an exposed height of 7.0 feet is located to the immediate west of the concrete collection basin. Another concrete retaining wall facing east spans the property from south to north along the west side of the existing residence. A concrete staircase extends up the slope along the north side of the detached garage on the site. Another concrete retaining wall facing east is located to the north of the concrete staircase.

In general surface grades in the vicinity of the site slope down to the east. Surface grades on the site slope down to the east at surface grades ranging from 0 to 40 percent. Elevation relief across the site is approximately 25.0 feet. Site vegetation consists of various landscape bushes and trees with some grass lawn areas around the residence. The western (uphill) end of the site is vegetated with several medium-sized evergreen and deciduous trees with thick underbrush.

3.2 Mapped Soils

According to *The Geologic Map of Mercer Island,* by Kathy G. Troost and Aaron P. Wisher (October 2006), the soil in the vicinity of the site is mapped as Lawton Clay (Qvlc). However, based on our site exploration, the soils underlying the surface of the site would be better classified as Mass Wastage. The soil along the main portion of the site is underlain with Advance Outwash-like soils (Qva). The soil along the western (uphill) end of the site is underlain with Glacial Till-like soils (Qvt). These soils originated from the upper portion of the slope and were deposited on the site by landslides that occurred when the glacial ice mass began retreating approximately 12,000 years ago.

The near surface soils at the site have been disturbed by natural weathering processes that have occurred since their deposition. Groundwater seepage was observed along the south side of the existing residence on the site. A copy of the Geologic Map for the subject site is provided in Figure 3.

According to the United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS), the soils underlying the site are classified as Kitsap Silt Loam (KpD) soils that form on 15 to 30 percent slopes. According to the USDA NRCS, the Kitsap soils will have a severe potential for erosion when exposed. A copy of the USDA NRCS Map for the subject site is provided in Figure 4.

3.3 Soils

The soils we observed at the site generally consist of old fill soils overlying Mass Wastage consisting of sand with silt and gravel consistent with Advance Outwash and silty sand with gravel consistent with Glacial Till.

In Test Hole TH-1, located near the NE corner of the existing residence, we encountered 9 inches of topsoil overlying moist, medium dense, reddish-orange silty sand with gravel to a depth of 2.5 feet below surface grades. Below a depth of 2.5 feet we encountered moist, medium dense to dense, light brown sand with silt and gravel consistent with Advance Outwash. In Test Hole TH-2, located along the south side of the existing residence on the site, we encountered old fill soils to a depth of 2.5 feet below surface grades. The fill consisted of moist, medium dense, brown sand with silt and gravel with some topsoil. Below 2.5 feet, the soils became medium dense to dense, light brown sand with silt and gravel consistent with Advance Outwash. In Test Hole TH-3, located near the NW corner of the existing residence on the site, we encountered 3 inches of topsoil overlying old fill soils to a depth of 5.0 feet below surface grades. The fill consisted of moist, medium dense, brown sand with silt and gravel with some topsoil. In Test Hole TH-4, located along the east side of the driveway where it extends off East Mercer Way, we encountered moist, very dense, gray silty sand with gravel consistent with Glacial Till.

Figures A-1 through A-3 present more detailed descriptions of the subsurface conditions encountered in the test holes. The approximate test hole locations are shown on the Exploration Location Plan provided in Figure 2.

3.4 Groundwater

We did not encounter groundwater seepage in any of the test holes excavated on the site. However, we expect a seasonal perched water table likely develops on top of the dense glacial till during periods of wet weather. The 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).

Groundwater seepage was observed emanating from the center of the sites' southern property line. The water is currently allowed to flow freely over the property line to a concrete collection basin constructed in the ground. The collected water then flows into a storm water pipe.

4.0 GEOLOGIC HAZARDS

4.1 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".

4.2 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 observed evidence of mass wastage on the site. We observed slopes steeper than 15 percent on the site, and groundwater seepage on the slope adjacent the site. And there is likely relatively permeable sediment overlying a relatively impermeable sediment or bedrock. We observed groundwater seepage emanating from the slope to the south of current residence location. The seepage is allowed to flow freely onto the slope face where it has been historically channeled onto the south end of the subject site to a collection area. We did observe the site is covered by mass wastage debris from past movements. We did not observe any areas of rapid stream incision. We observed areas sloping 40 percent or greater along the eastern (uphill) end of the site. However, the height of these slopes is less than 30 feet. Based on the Mass Wastage underlying the site, according to the city of Mercer Island municipal code, the site is classified as a landslide hazard area.

4.3 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 have any areas sloping steeper than 15 percent along the western end of the site. Based on our subsurface exploration, the site is underlain with soils having a "severe" potential for erosion when exposed. Therefore, according to the City of Mercer Island municipal code, the eastern end of the site is classified as having erosion hazard areas. We expect the planned development will not encroach into the steep slope area along the east end of the site.

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.

4.4 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. The site is located within the Seattle Fault Zone. 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 relatively coarse-grained 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 "D" can be used in structural design. 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 are assumed to be representative for the site conditions beyond the depths explored.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 General

Based on our study, in our opinion, soil and groundwater conditions at the site are suitable for the proposed development. The new structure can be supported on conventional spread footings bearing on the existing organic-free, undisturbed, native site soils observed at 0.0 to 5.0 feet below surface grades, or on structural fill placed above these existing soils. Prior to foundation construction, the exposed foundation subgrade should be compacted with heavy vibratory compaction equipment to determine if any soft or yielding areas exist. Floor slabs and pavements should be similarly supported. The development storm water should discharge to the existing system in use on the site.

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 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.

5.2 Development in Landslide Hazard Areas

According to Chapter 19.16.010, in the City of Mercer Island Municipal Code, development in Geologic hazard Areas is possible if certain conditions are met.

"B. General review requirements. Alteration within geologically hazardous areas or associated buffers is required to meet the standards in this section, unless the scope of work is exempt pursuant to section 19.07.120, exemptions, or a critical area review 1 approval has been obtained pursuant to section 19.07.090(A).
1. When an alteration within a landslide hazard area, seismic hazard area or buffer associated with those hazards is proposed, the applicant must submit a critical area study concluding that

the proposal can effectively mitigate risks of the hazard. The study shall recommend appropriate design and development measures to mitigate such hazards. The code official may waive the requirement for a critical area study and the requirements of subsections (B)(2) and (B)(3) of this section when he or she determines that the proposed development is minor in nature and will not increase the risk of landslide, erosion, or harm from seismic activity, or that the development site does not meet the definition of a geologically hazardous area.

2. Alteration of landslide hazard areas and seismic hazard areas and associated buffers may occur if the critical area study documents find that the proposed alteration:

a. Will not adversely impact other critical areas;

b. Will not adversely impact the subject property or adjacent properties;

c. Will mitigate impacts to the geologically hazardous area consistent with best available science to the maximum extent reasonably possible such that the site is determined to be safe; and

d. Includes the landscaping of all disturbed areas outside of building footprints and installation of hardscape prior to final inspection.

3. Alteration of landslide hazard areas, seismic hazard areas and associated buffers may occur if the conditions listed in subsection (B)(2) of this section are satisfied and the geotechnical professional provides a statement of risk matching one of the following:

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

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

c. Construction practices are proposed for the alteration that would render the development as safe as if it were not located in a geologically hazardous area and do not adversely impact adjacent properties; or

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

The historic landslide area is several blocks wide and long. Due to the size and the amount of development in the area our scope is limited to the site area and the effect the historic slide had on the site and can have on the subject site in the future. The site is currently safe from the historic hazard due to the mechanism that caused the event being over, the area consolidating over time and the massive development in the area that has re-shaped the affected locations. The primary concern is localized landslides resulting from groundwater and mass wastage on and adjacent the site, and liquefaction or excessive settling of the site.

Due to the site being underlain with relatively coarse-grained 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. A "Very Low" risk for liquefaction would typically require no additional design recommendations.

The Mass Wastage underlying the site appears to be large block sections of the soil that previously occupied the upper portion of the island slope in the site vicinity. This soil slid onto the site approximately 12,000 years ago and began consolidating (settling under its own weight). Consolidation is rapid at first and then slows down over time, theoretically never reaching zero, just getting closer into infinity. The timeframe of 12,000 years ago would indicate the rate of consolidation has slowed to a rate that is now relatively imperceptible. The soil has essentially completely settled under its own weight and is stable. Current or additional settlement of the site soil would then depend on the surface loading applied. The site has been developed with a single-family residence and its ancillary items for a relatively long time and therefore post construction settlements have already occurred. Inspection of the site surface indications slight to moderate distress of the surface walkways. The structure is sound with some typical foundation cracking, but nothing that would indicate excessive site settling or stability concerns.

The new residence will be located in the relatively flat area that exists between the residence that currently occupies the site and the detached garage. The new foundation areas will be prepared for the expected new loading conditions by compacting the exposed surface with heavy vibratory compaction equipment prior to construction. Inspection of the site structures and site surface indicates the site is currently stable. We observed slight to moderate surface distress across the site. Based on our evaluation, by following typical construction practices in the vicinity, replacing the residence with a new residence will not increase the risk of landslides on the site. It doesn't appear the residence replacement will adversely impact other critical areas. It doesn't appear the residence replacement will adversely impact the subject property or adjacent properties. By building in the flat area and exposing and compacting the surface of the site before foundations construction, it appears the residence replacement will mitigate impacts to the geologically hazardous area consistent with best available science to the maximum extent reasonably possible such that the site is determined to be safe. It appears the residence replacement will include the landscaping of all disturbed areas outside of building footprints and installation of hardscape prior to final inspection.

Based on our evaluation, it appears the existing residence on the site can be demolished and the site developed with a new residence. The landslide hazard area or seismic hazard area will be modified or the development has been designed so that the risk to the site and adjacent property is eliminated or mitigated such that the site is determined to be safe.

5.2 Site Preparation and Grading

To prepare the site for construction, all vegetation, organic surface soils, and other deleterious materials including any existing structures, foundations or abandoned utility lines should be stripped and removed from the new development areas. Organic topsoil will not be suitable for use as structural fill but may be used for limited depths in non-structural areas. The existing old fill soils and disturbed native soils observed in the upper 0.0 to 5.0 feet will not be suitable for support of structural elements. Prior to construction, these unsuitable soils should be removed from under new development areas.

Once clearing and stripping operations are complete, cut and fill operations can be initiated to establish desired grades. In order to achieve proper compaction of structural fill, and to provide adequate foundation and floor slab support, the native subgrade must be in a stable condition. Prior to placing structural fill, and to prepare the foundation subgrade, all exposed surfaces should be compacted with heavy vibratory compaction equipment to determine if any isolated soft and yielding areas are present.

If excessively soft or yielding areas are present, and cannot be stabilized in place by compaction, they should be cut to firm bearing soil and filled to grade with structural fill. If the depth to remove the unsuitable soil is excessive, using a geotextile fabric can be considered, such as Mirafi HP270 or an approved equivalent, in conjunction with structural fill. In general, a minimum of 18-inches of clean, granular structural fill over the geotextile fabric should establish a stable bearing surface.

A representative of Ages Engineering should observe the foundation subgrade compaction operations to verify that stable subgrades are achieved for support of structural elements.

Our study indicates the native surface soils encountered at the site contain a sufficient 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 are planned during the wet winter months, or the on-site soils become too wet to achieve adequate compaction, the owner should be prepared to import a wet-weather structural fill. For wet weather structural fill, we recommend importing a granular soil that meets the following gradation requirements:

U. S. Sieve Size	Percent Passing
6 inches	100
No. 4	75 maximum
No. 200	5 maximum*

* Based on the ¾ inch fraction

Prior to use, Ages Engineering should examine and test all materials to be imported to the site for use as structural fill.

Structural fill should be placed in uniform loose layers not exceeding 12 inches and compacted to a minimum of 95 percent of the soils' laboratory maximum dry density as determined by American Society for Testing and Materials (ASTM) Test Designation D-1557 (Modified Proctor). The moisture content of the soil at the time of compaction should be within two percent of its optimum, as determined by this same ASTM standard. In non-structural areas, the degree of compaction can be reduced to 90 percent.

5.3 Excavations

General,

The inclination for a safe and stable excavation slope cut is determined based on two factors, the current Washington State Safety and Health Administration (WSHA) regulations for confined spaces and global stability of the slope cut. Most often, the WSHA regulations are more conservative than the global stability requirements.

According to WAC 296-809-099, a confined space is defined as: "A space that is all of the following:

(a) Large enough and arranged so an employee could fully enter the space and work.

(b) Has limited or restricted entry or exit. Examples of spaces with limited or restricted entry are tanks, vessels, silos, storage bins, hoppers, vaults, excavations, and pits.

(c) Not primarily designed for human occupancy."

In the context of site excavation and grading, the Washington State Department of Labor and Industries considers a confined space as a space in which a worker enters an excavation that is tall enough and/or narrow enough to inundate the worker and cause bodily harm if a cave-in occurs. This does not include excavations that are less than 4.0 feet in depth.

WSHA Approved Slopes,

All excavations at the site associated with confined spaces, such as utility trenches and lower level building and retaining walls, must be completed in accordance with local, state, and/or federal requirements. Based on current Washington State Safety and Health Administration (WSHA) regulations, the existing near-surface loose to medium dense soils and the weathered medium dense native soils would be classified as Type C soils. The deeper dense native Advance Outwash soils would be classified as Type B soils. The deeper dense native Glacial Till soils would be classified as Type A soils.

According to WSHA, for temporary excavations of less than 20 feet in depth, the side slopes in Type C soils should be laid back at a slope inclination of 1.5:1 (Horizontal:Vertical) or flatter from the toe to the crest of the slope. The side slopes in Type B soils should be laid back at a slope inclination of 1:1 (Horizontal:Vertical) or flatter from the toe to the crest of the slope. The side slopes in Type A soils should be laid back at a slope inclination of 0.75:1 (Horizontal:Vertical) or flatter from the toe to the crest of the slope. All exposed slope faces should be covered with a durable reinforced plastic membrane during construction to prevent slope raveling and rutting during periods of precipitation. These guidelines assume that all surface loads are kept at a minimum distance of at least one half the depth of the cut away from the top of the excavation slope and that significant seepage is not present on the slope face. Flatter cut slopes will be necessary where significant raveling or seepage occurs, or if construction materials will be stockpiled along the slope crest. If these safe temporary slope inclinations cannot be achieved due to property line constraints, shoring may be necessary.

Non-WSHA Approved Slopes,

Based on the composition and consistency of the site soils, stable slope cuts to provide adequate global stability can be steeper than WSHA standards in areas that are not considered confined spaces. Excavations into the native site soils that will not result in WSHA regulated confined spaces can be cut to an inclination of 0.5:1. Some raveling of the gravel and cobbles exposed on the slope surface may occur at an inclination of 0.5:1. Due to the potential for raveling to occur, and to prevent erosion, the slope face should be covered with durable plastic sheeting.

This information is provided solely for the benefit of the owner and other design consultants and should not be construed to imply that Ages Engineering assumes responsibility for job site safety. It is understood that job site safety is the sole responsibility of the project contractor.

5.4 Foundations

The new residential foundations may be supported on conventional spread footing foundations bearing on the competent native organic-free soils or on structural fills placed above these native soils. Foundation subgrades should be prepared as recommended in the "Site Preparation and Grading" section of this report.

According to the "Site Preparation and Grading" section of this report, the existing old fill soils and disturbed native soils observed in the upper 0.0 to 5.0 feet will not be suitable for support of structural elements. Prior to construction, these unsuitable soils should be removed from under new foundation areas. Prior to placing the foundation forms, and to prepare the foundation subgrade, all exposed foundation surfaces should be compacted with heavy vibratory compaction equipment to determine if any isolated soft and yielding areas are present.

Perimeter foundations exposed to the weather should bear at a minimum depth of 1.5 feet below final exterior grades for frost protection. Interior foundations can be constructed at any convenient depth below the floor slab. We recommend designing new foundations for a net allowable bearing capacity of 2,500 pounds per square foot (psf). For short-term loads, such as wind and seismic, a one-third increase in this allowable capacity can be used. With the anticipated loads and this bearing stress applied, building settlements should be less than one-half inch total and one-quarter inch differential.

For designing foundations to resist lateral loads, a base friction coefficient of 0.35 can be used. Passive earth pressures acting on the sides of the footings can also be considered. We recommend calculating this lateral resistance using an equivalent fluid weight of 325 pounds per cubic foot (pcf). We recommend not including the upper 12 inches of soil in this computation because it can be affected by weather or disturbed by future grading activity. This value assumes the foundations will be constructed neat against competent soil and backfilled with structural fill, as described in the "Site Preparation and Grading" section of this report. The values recommended include a safety factor of 1.5.

Foundation Parameter Summary	
Description	***Design Value**
Net Allowable Bearing Capacity	2,500 psf
Friction Coefficient	0.35
Lateral Resistance	325 pcf

*Details regarding the use of these parameters are provided in the section above.

5.5 Slab-On-Grade

Slab-on-grade floors should be supported on subgrades prepared as recommended in the "Site Preparation and Grading" section of this report. According to the "Site Preparation and Grading" section of this report, the existing old fill soils and disturbed native soils observed in the upper 0.0 to 5.0 feet will not be suitable for support of structural elements. Prior to construction, this unsuitable soil should be removed from under new slab areas.

Immediately below the floor slab, we recommend placing a four-inch-thick capillary break layer of clean, free-draining, coarse sand or fine gravel that has less than three percent passing the No. 200 sieve. This material will reduce the potential for upward capillary movement of water through the underlying soil and subsequent wetting of the floor slabs. The drainage material should be placed in one lift and compacted to a firm and unyielding condition.

The capillary break layer will not prevent moisture intrusion through the slab caused by water vapor transmission. Where moisture by vapor transmission is undesirable, such as covered floor areas, a common practice is to place a durable plastic membrane on the capillary break layer and then cover the membrane with a layer of clean sand or fine gravel to protect it from damage during construction, and aid in uniform curing of the concrete slab. It should be noted that if the sand or gravel layer overlying the membrane is saturated prior to pouring the slab, it will not assist in uniform curing of the slab and may serve as a water supply for moisture transmission through the slab and affecting floor coverings. Additionally, if the sand is too dry, it can effectively drain the fresh concrete, thereby lowering its strength. Therefore, in our opinion, covering the membrane with a layer of sand or gravel should be avoided.

5.6 Lower Level and Building Walls

The magnitude of earth pressure development on below-grade walls, such as basement or retaining walls, will greatly depend on the quality of the wall backfill and the wall drainage. We recommend placing and compacting wall backfill as structural fill. Wall backfill below structurally loaded areas, such as pavements or floor slabs, should be compacted to a minimum of 95 percent of its maximum dry density, as determined by ASTM Test Designation D-1557 (Modified Proctor). In unimproved areas, the relative compaction can be reduced to 90 percent.

To guard against hydrostatic pressure development, drainage must be installed behind the wall. We recommend that wall drainage consist of a minimum 12 inches of clean sand and/or gravel with less than three percent fines placed against the back of the wall. In addition, a drainage collector system consisting of 4-inch perforated PVC pipe should be placed behind the wall to provide an outlet for any accumulated water. The drains should be provided with cleanouts at easily accessible locations. These cleanouts should be serviced at least once every year. The wall drainage material should be capped at the ground surface with 1-foot of relatively impermeable soil to prevent surface intrusion into the drainage zone. Alternatively, the 12-inch-wide drainage layer placed against the back of the wall can be replaced with a Mirafi G100N Drainage Board, or an approved equivalent. If drainage board is used, the 4-inch perforated PVC pipe should be covered with at least 12 inches of clean washed gravel and the drainage board should be hydraulically connected to drainpipe and surrounding gravel.

With wall backfill placed and compacted as recommended and the wall drainage properly installed, unrestrained walls can be designed for an active earth pressure equivalent to a fluid weighing 35 pcf. For restrained walls, an additional uniform lateral pressure of 100 psf should be included. These values assume a horizontal backfill condition and that no other surcharge loading, such as traffic, sloping embankments, or adjacent buildings, will act on the wall. If such conditions exist, then the imposed loading must be included in the wall design. Friction at the base of the wall foundation and passive earth pressure will provide resistance to these lateral loads. Values for these parameters are provided in the "Foundations" section of this report.

Lower Level Building and Retaining Wall Parameter Summary		
Description	**Condition**	***Design Value**
Earth Pressure	Unrestrained	35 pcf
Earth Pressure	Restrained	Additional 100 psf
Earth Pressure	Surcharge	Dependent upon magnitude

*Details regarding the use of these parameters are provided in the section above.

5.7 Storm Water

The storm water collected in the roof and foundation drains should discharge off of the site to the existing storm water system currently in place on the site.

5.8 Permanent Slopes and Embankments

All permanent cut and fill slopes should be graded with a finished inclination of no greater than 2:1 (Horizontal:Vertical). Upon completion of grading, the slope face should be appropriately vegetated or provided with other physical means to guard against erosion. Final grades at the top of the slope must promote surface drainage away from the slope crest. Water must not be allowed to flow in an uncontrolled fashion over the slope face. If it is necessary to direct surface runoff towards the slope, it should be controlled at the top of the slope, piped in a closed conduit installed on the slope face, and taken to an appropriate point of discharge beyond the toe.

All fill used for slope and embankment construction should meet the structural fill requirements described in the Site Preparation and Grading section of this report. In addition, if new fills will be placed over existing slopes of 20 percent or greater, the structural fill should be keyed and benched into competent slope soils.

5.9 Site Drainage

Surface,

Final exterior grades should promote free and positive drainage away from the building area. All ground surfaces, pavements, and sidewalks should be sloped away from the structure. We recommend providing a gradient of at least three percent for a minimum distance of ten feet from the building perimeter, except in paved locations. In paved locations, a minimum gradient of one percent should be provided, unless provisions are included for collection and disposal of surface water adjacent to the structure.

Subsurface,

We recommend installing a continuous drain along the lower outside edge of the perimeter building foundation. The foundation drain should be tightlined to an approved point of controlled discharge. The roof drain should not be connected to the footing drains unless a backflow device will be installed, or an adequate gradient will prevent backflow into the footing drains.

Subsurface drains must be laid with a gradient sufficient to promote positive flow to the point of discharge. All drains should be provided with cleanouts at easily accessible locations. These cleanouts should be serviced at least once every year.

6.0 ADDITIONAL SERVICES

Ages Engineering 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.

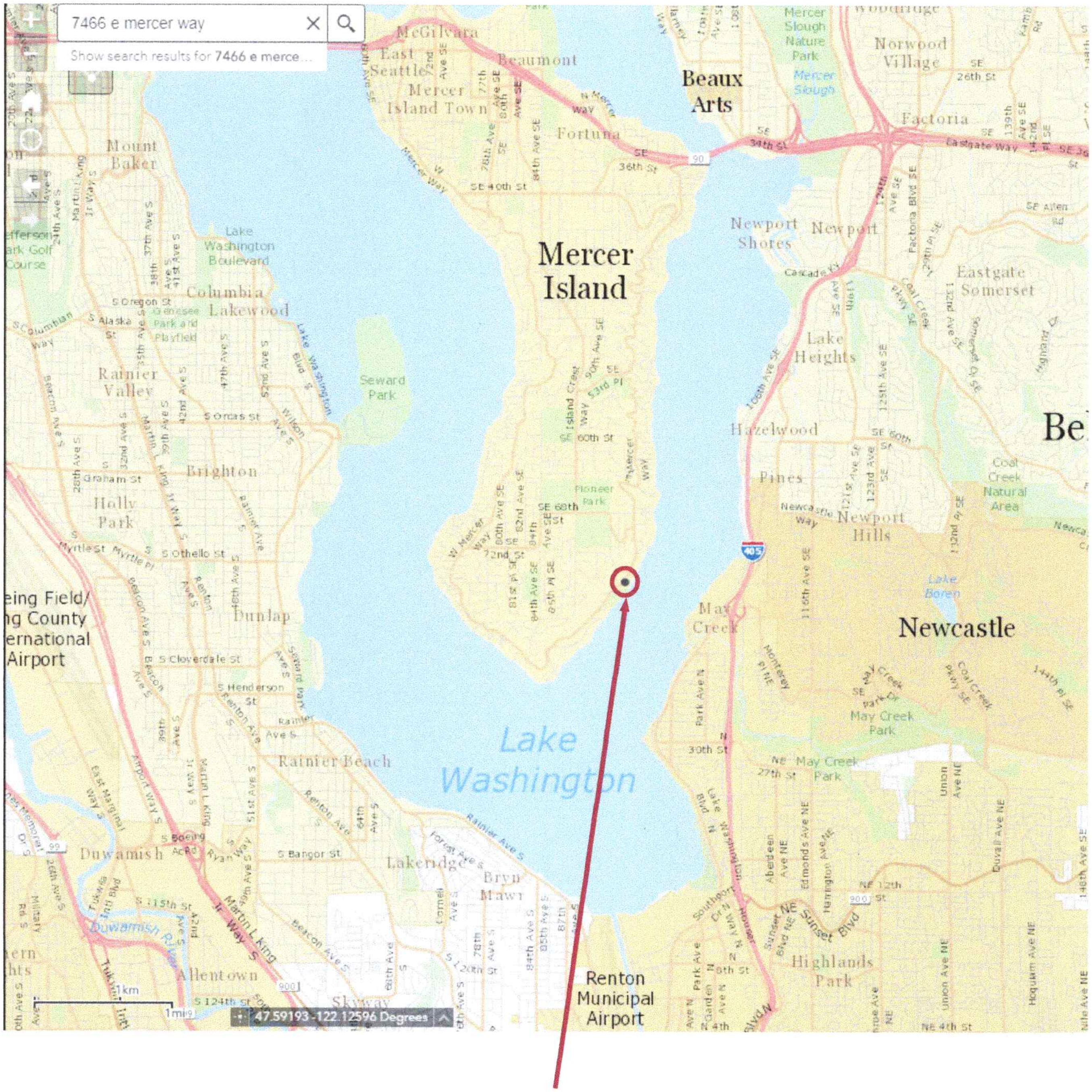
We should also provide geotechnical services during construction to observe compliance with our design concepts, specifications, and recommendations. This will allow for expedient design changes if subsurface conditions differ from those anticipated prior to the start of construction.

7.0 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 and is intended for the exclusive use of Ms. Sella Ramaiyah and her 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 the time of construction. If variations appear evident, Ages Engineering 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.



Approximate Site Location

Ages Engineering P. O. Box 935 Puyallup, WA. 98371 Main (253) 845-7000 www.agesengineering.com	**Site Vicinity Map** Ramaiyah Residence 7466 East Mercer Way Mercer Island, Washington		
	Project No.: A-1562-1	September 2024	**Figure 1**

KEY:

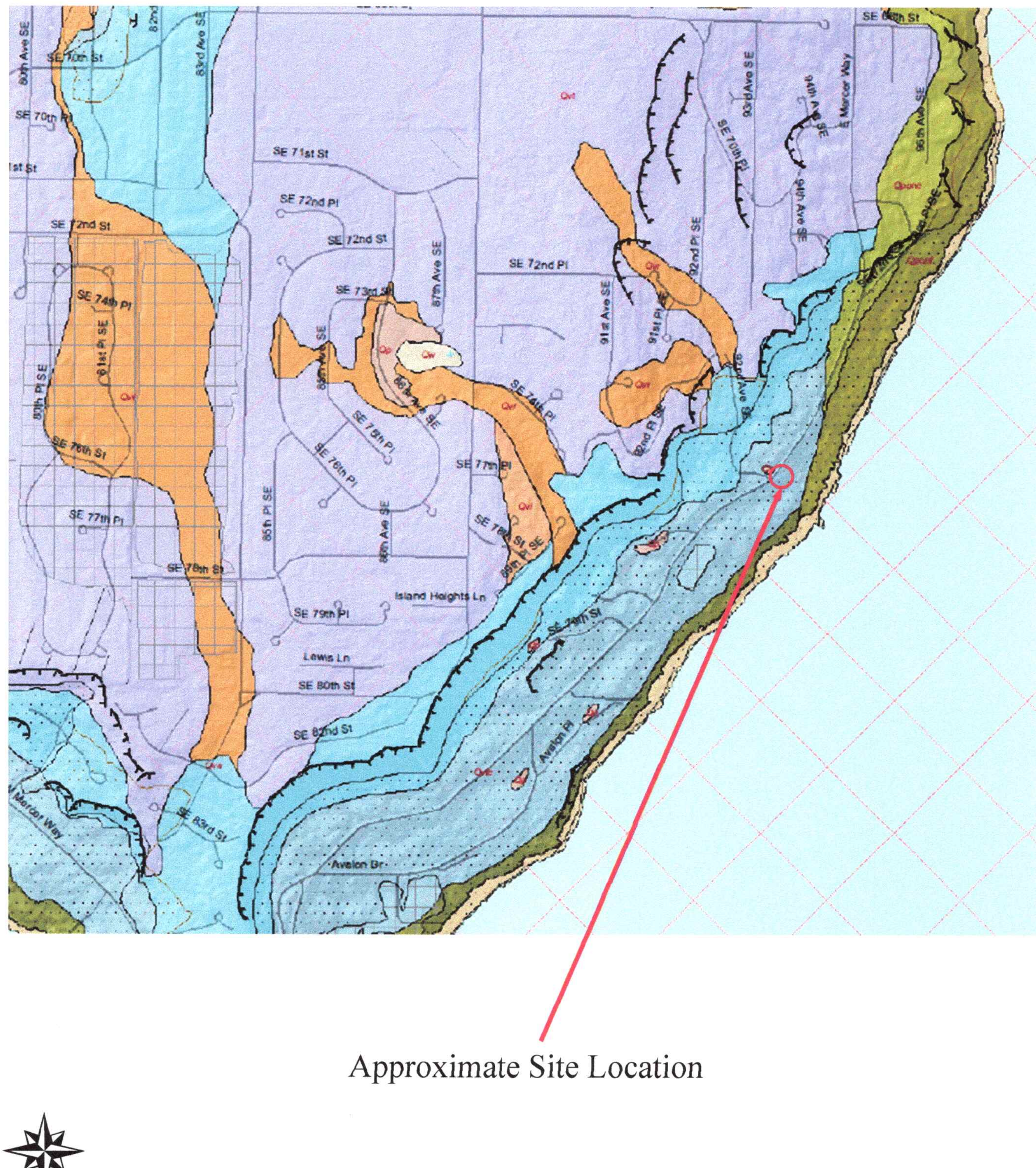
APPROXIMATE LOCATION OF TEST HOLE TH-1 ♦

Ages Engineering
P. O. Box 935
Puyallup, WA. 98371

Main (253) 845-7000
www.agesengineering.com

Exploration Location Plan
Ramaiyah Residence
7466 East Mercer Way
Mercer Island, Washington

Project No.: A-1562-1	September 2024	**Figure 2**



Ages Engineering
P. O. Box 935
Puyallup, WA. 98371

Main (253) 845-7000
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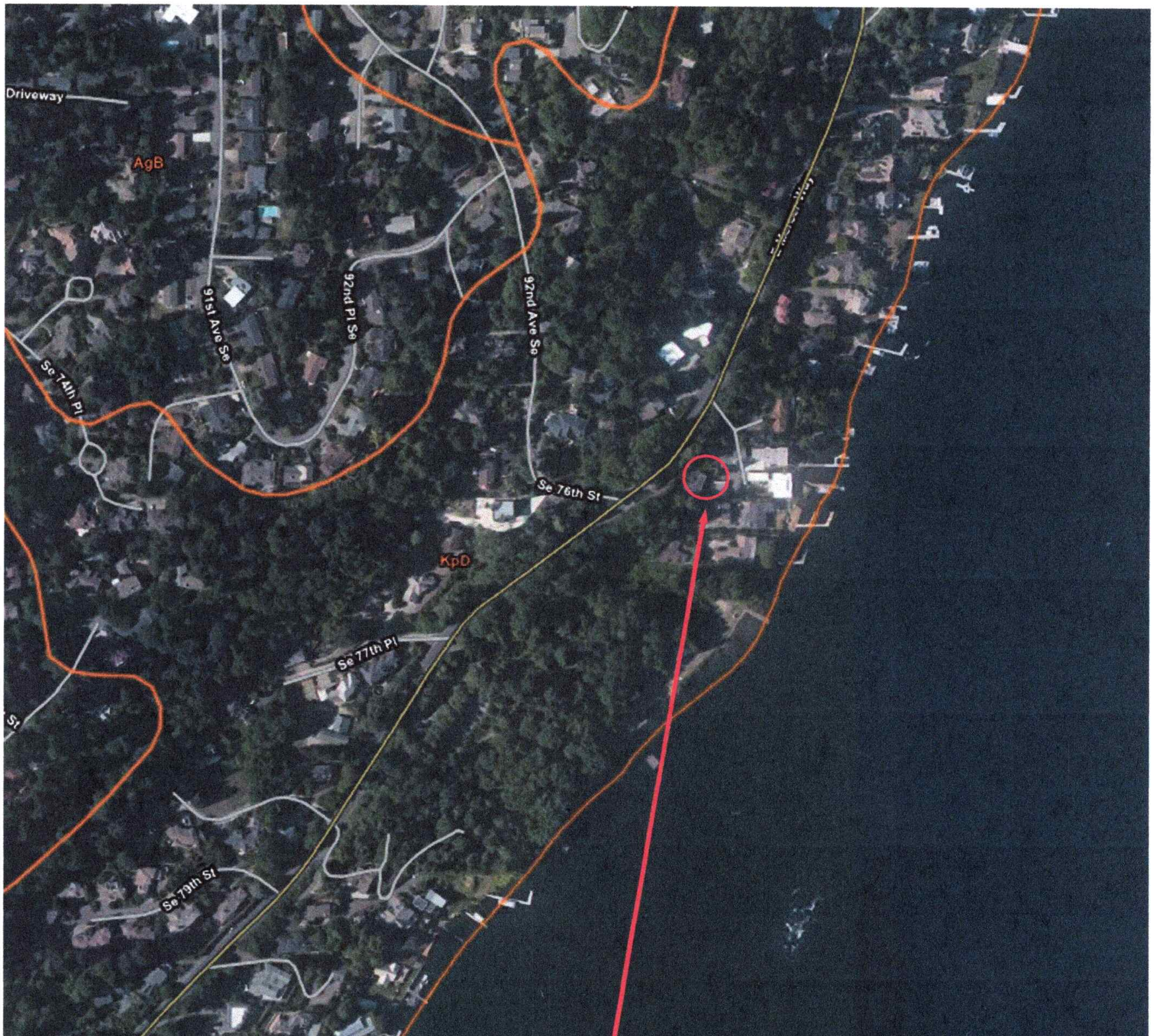
Geologic Map
Ramaiyah Residence
7466 East Mercer Way
Mercer Island, Washington

Project No.: A-1562-1	September 2024	**Figure 3**



Approximate Site Location

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USDA NRCS Map

Ramaiyah Residence
7466 East Mercer Way
Mercer Island, Washington

Project No.: A-1562-1	September 2024	**Figure 4**

APPENDIX A

FIELD EXPLORATION AND LABORATORY TESTING

Ramaiyah Residence
Mercer Island, Washington

On June 29, 2020 we explored subsurface conditions at the site by advancing four hand-augured test holes to a maximum depth of 7.0 feet below surface grades. We visited the site again on June 21, 2024 to view existing site conditions. The approximate test hole locations are shown on the Exploration Location Plan provided in Figure 2.

A geotechnical engineering representative from our office conducted the field exploration, maintained a log of each test hole and, classified the soils encountered, collected representative soil samples, and observed pertinent site features. All soil samples were visually classified in accordance with the Unified Soil Classification System (USCS) described on Figure A-1. The test hole logs are presented on Figures A-2 and A-3.

Representative soil samples obtained from the test holes were placed in sealed containers and taken to our laboratory for further examination and testing. The moisture content of each sample was measured and is reported on the test hole logs.

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)
Ramaiyah Residence
7466 East Mercer Way
Mercer Island, Washington

Project No.: A-1562-1 | September 2024 | **Figure A-1**

Test Hole TH-1

DATE: June 29, 2020 LOGGED BY: BPK ELEV:

Depth (feet)	Soil Description	Notes M%	Notes Other
0	9 inches **TOPSOIL**		
	Reddish-orange silty **SAND** with gravel, medium dense, moist. (SM)		
5	**Mass Wastage:** Light brown **SAND** with silt and gravel, cobbles to 5 inches, moist, medium dense. (SM) (Consistent with Advance Outwash)		

Test Hole terminated at a depth of 7.0 feet below surface grades.

No groundwater seepage encountered.

Test Hole TH-2

DATE: June 29, 2020 LOGGED BY: BPK ELEV:

Depth (feet)	Soil Description	Notes M%	Notes Other
0	**FILL:** Brown sand with silt and gravel, some topsoil, medium dense, moist. (SM)		
5	**Mass Wastage:** Light brown SAND with silt and gravel, cobbles to 5 inches, moist, medium dense. (SM) (Consistent with Advance Outwash)		

Test Hole terminated at a depth of 7.0 feet below surface grades.

No groundwater seepage encountered.

Figure A-2