**GEOTECH**
**CONSULTANTS, INC.**

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May 1, 2018

JN 18194

Robert Peha
7653 West Mercer Way
Mercer Island, Washington 98040

*via email: dpeha@comcast.net*

Subject: **Geotechnical Engineering Report**
Proposed Residence Additions
7653 West Mercer Way
Mercer Island, Washington

Dear Mr. Peha:

We are pleased to present this geotechnical engineering report for the proposed residence remodel project in Mercer Island. The scope of our services consisted of exploring site surface and subsurface conditions, and then developing this report to provide recommendations for general earthwork and design considerations for foundations, retaining walls, subsurface drainage, and temporary excavations. This work was authorized by your acceptance of our proposal, P-10061, dated April 13, 2018.

We were provided with a site plan prepared by Plog Real Estate and Consulting dated October 4, 2017. We were also provided with floor plans prepared by SHKS Architects dated December 12, 2017. Based on these plans, we understand that the development will consist of two additions to the main level of the existing residence. One addition will be a porch and entry at the northeast corner, and the other will be living space at the southeast corner. An existing partial basement underlies the central part of the residence; the north addition will be just north of the basement and the south addition will be just south of the basement. We expect that crawlspaces will underlie the additions. The south edge of the south addition will be at the base of a tall, steep slope.

If the scope of the project changes from what we have described above, we should be provided with revised plans in order to determine if modifications to the recommendations and conclusions of this report are warranted.

## ***SITE CONDITIONS***

### ***SURFACE***

The Vicinity Map, Plate 1, illustrates the general location of the site in Mercer Island. The site is accessed via a shared driveway and is surrounded by several residences.

The ground surface within the site declines toward the west to northwest with an inclination that is mostly moderate to steep. The driveway that accesses the residence from the northwest and the northern parking area have clearly been graded into an existing slope. We did not observe indications of recent instability of the site slopes.

The property is developed with a one-story residence that is partially underlain by a central basement that daylights toward the north and west. Open space underlies the north, west, and south ends of the main level, with a carport below the north end. We did not observe significant cracking of the exposed concrete walls of the basement.

A drainage enters the site near the center of the eastern property line and flows to the north. It enters a culvert and crosses the northern parking area, emerging in the western yard. The undeveloped areas of the site are vegetated with young to mature trees, brush, and landscaping bushes.

The 2009 Mercer Island Landslide Hazard Assessment map shows that the property and surrounding area is considered a Landslide Hazard Area. It is mapped as being underlain by landslide deposits, and as being steeper than 15 percent. Several old landslides are mapped close to the property. In addition, that map shows that the contact line of coarse-grained soil over fine-grained soil is just upslope of the site. The 2009 Mercer Island Erosion Hazard Assessment map classifies the property as an Erosion Hazard Area.

## *SUBSURFACE*

The subsurface conditions were explored by excavating two test holes at the approximate locations shown on the Site Exploration Plan, Plate 2. Our exploration program was based on the proposed construction, anticipated subsurface conditions and those encountered during exploration, and the scope of work outlined in our proposal. The test holes were excavated on April 17, 2018 using hand tools. The Test Hole Logs are attached to this report as Plate 3.

### ***Soil Conditions***

Test Hole 1 was close to the southeast corner of the proposed southern addition. It encountered one foot of topsoil and then silty sand with gravel that was initially loose, then became loose to medium-dense at 2 feet and medium-dense at 2.5 feet. Medium-dense sand with gravel was present from 3 to 4 feet, and then the hole revealed medium-dense silt.

We performed Test Hole 2 near the east edge of the proposed northern addition. That revealed 0.5 feet of topsoil and then loose silty sand with gravel. At 2.5 feet the exploration found medium-dense silt.

### ***Groundwater Conditions***

No groundwater seepage was observed in the test holes, which were left open for only a short time period. It should be noted that groundwater levels vary seasonally with rainfall and other factors. We anticipate that groundwater could be found in more permeable soil layers and between the looser near-surface soil and the underlying denser and fine-grained soil.

The stratification lines on the logs represent the approximate boundaries between soil types at the exploration locations. The actual transition between soil types may be gradual, and subsurface conditions can vary between exploration locations. The logs provide specific subsurface information only at the locations tested. The relative densities and moisture descriptions indicated on the test hole logs are interpretive descriptions based on the conditions observed during excavation.

## CONCLUSIONS AND RECOMMENDATIONS

### GENERAL

*THIS SECTION CONTAINS A SUMMARY OF OUR STUDY AND FINDINGS FOR THE PURPOSES OF A GENERAL OVERVIEW ONLY. MORE SPECIFIC RECOMMENDATIONS AND CONCLUSIONS ARE CONTAINED IN THE REMAINDER OF THIS REPORT. ANY PARTY RELYING ON THIS REPORT SHOULD READ THE ENTIRE DOCUMENT.*

The test holes conducted for this study encountered medium-dense native soil at depths of 2.5 feet. However, the sides of the additions close to the existing basement retaining walls will overlie up to about 8 feet of backfill that was placed against the retaining walls after they were constructed. In our experience that this backfill is always loose and is not capable of supporting foundation loads without excessive settlement. Additionally, new foundations constructed close to the top of the existing basement walls would impose a lateral surcharge on the walls, which may not be capable of resisting that load.

Considering the limited access, and the likely presence of uncompacted fill over much of the new development area, we recommend that the additions be supported on driven, small-diameter pipe piles. This would be quicker and less costly than attempting to excavate to suitable bearing soils for conventional footings.

Based on our shallow explorations and our experience in the vicinity, we believe that the core of the site consists of dense native soil that has a very low potential for deep-seated landslides. However, like any steep slope in the Puget Sound region, there is a potential for shallow failures in the near-surface soils. Such failures are usually triggered by heavy rainfall and/or concentrated water flowing over the slope. The potential for failures can be reduced by maintaining vegetation on the slopes and directing water away from the slopes. The recommendations presented in this report are intended to prevent adverse impacts to the stability of the steep slope above the residence. It is possible that soil and debris from any future shallow slides on the steep slopes could strike the proposed southern addition. To protect occupants of the new construction, we recommend that a catchment wall constructed of reinforced concrete extend at least 5 feet above the existing slope grade to catch or slow material that may travel down the slope in a slide. The catchment wall should be constructed along the entire south side of the southern addition. No openings such as doors or windows should be within that catchment height. This lessens the risk to any potential occupants who may be in the addition in the event of a landslide. It is difficult to assess the pressures that this wall should be designed for, but it would be appropriate for the wall to be sufficiently reinforced to handle an active earth pressure of 100 pounds per cubic foot (pcf) acting over a 5-foot height. Siding can be extended down over the concrete walls for aesthetic purposes, if desired.

In order to satisfy the City of Mercer Island's requirements, we make the following statement:

> "It is our professional opinion that the development practices proposed in this report for the proposed additions would render the development as safe as if it were not located in a geologic hazard area."

The planned development is relatively limited in area, and will not cause a large area of ground disturbance. We anticipate that “typical” temporary erosion control measures will be sufficient to mitigate the potential risk of erosion problems during construction. The erosion control measures needed during the site development will depend heavily on the weather conditions that are encountered. We anticipate that a silt fence will be needed around the downslope sides of any cleared areas. Existing pavements, ground cover, and landscaping should be left in place wherever possible to minimize the amount of exposed soil. Rocked staging areas and construction access roads should be provided to reduce the amount of soil or mud carried off the property by trucks and equipment. Trucks should not be allowed to drive off of the rock-covered areas. Cut slopes and soil stockpiles should be covered with plastic during wet weather. We expect that most or all of the excavated soil will have to be hauled away. Following clearing or rough grading, it may be necessary to mulch or hydroseed bare areas that will not be immediately covered with landscaping or an impervious surface. On most construction projects, it is necessary to periodically maintain or modify temporary erosion control measures to address specific site and weather conditions.

The drainage and/or waterproofing recommendations presented in this report are intended only to prevent active seepage from flowing through concrete walls or slabs. Even in the absence of active seepage into and beneath structures, water vapor can migrate through walls, slabs, and floors from the surrounding soil, and can even be transmitted from slabs and foundation walls due to the concrete curing process. Water vapor also results from occupant uses, such as cooking, cleaning, and bathing. Excessive water vapor trapped within structures can result in a variety of undesirable conditions, including, but not limited to, moisture problems with flooring systems, excessively moist air within occupied areas, and the growth of molds, fungi, and other biological organisms that may be harmful to the health of the occupants. The designer or architect must consider the potential vapor sources and likely occupant uses, and provide sufficient ventilation, either passive or mechanical, to prevent a build up of excessive water vapor within the planned structure.

Geotech Consultants, Inc. should be allowed to review the final development plans to verify that the recommendations presented in this report are adequately addressed in the design. Such a plan review would be additional work beyond the current scope of work for this study, and it may include revisions to our recommendations to accommodate site, development, and geotechnical constraints that become more evident during the review process.

We recommend including this report, in its entirety, in the project contract documents. This report should also be provided to any future property owners so they will be aware of our findings and recommendations.

## *SEISMIC CONSIDERATIONS*

In accordance with the International Building Code (IBC), the site class within 100 feet of the ground surface is best represented by Site Class Type D (Stiff Soil). As noted in the USGS website, the mapped spectral acceleration value for a 0.2 second ($S_s$) and 1.0 second period ($S_1$) equals 1.47g and 0.56g, respectively.

The IBC and ASCE 7 require that the potential for liquefaction (soil strength loss) during an earthquake be evaluated for the peak ground acceleration of the Maximum Considered Earthquake (MCE), which has a probability of occurring once in 2,475 years (2 percent probability of occurring in a 50-year period). The MCE peak ground acceleration adjusted for site class effects ($F_{PGA}$) equals 0.61g. The soils beneath the site are not susceptible to/have a low potential for seismic liquefaction under the ground motions of the MCE because of the absence of near-surface groundwater.

## *PIPE PILES*

A 2-inch-diameter pipe pile driven with a minimum 90-pound jackhammer or a 140-pound Rhino hammer to a final penetration rate of 1-inch or less for one minute of continuous driving may be assigned an allowable compressive load of 3 tons. Extra-strong steel pipe should be used. The site soils are not highly organic, and are not located near salt water. As a result, they do not have an elevated corrosion potential. Considering this, it is our opinion that standard "black" pipe can be used, and corrosion protection, such as galvanizing, is not necessary for the pipe piles. Subsequent pipe sections should be connected together using threaded or slip couplers, or by welding. If slip couplers are used, they must fit snugly into the ends of the pipes. This can require that shims or beads of welding flux be applied to the couplers.

Lateral loads may be resisted by passive earth pressure acting on the vertical, embedded portions of the foundation. For this condition, the foundation must be either poured directly against relatively level, undisturbed soil or surrounded by level structural fill. We recommend using a passive earth pressure of 200 pounds per cubic foot (pcf) for this resistance. If the ground in front of a foundation is loose or sloping, the passive earth pressure given above will not be appropriate. We recommend a safety factor of at least 1.5 for the foundation's resistance to lateral loading, when using the above ultimate passive value. Due to their small diameter, the lateral capacity of vertical pipe piles is negligible. However, if lateral resistance in addition to the passive soil pressure is required, we recommend driving battered piles in the same direction as the applied lateral load. The lateral capacity of a battered pile is equal to one-half of the lateral component of the allowable compressive load, with a maximum allowable lateral capacity of 500 pounds. The allowable vertical capacity of battered piles does not need to be reduced if the piles are battered steeper than 1:5 (Horizontal:Vertical).

Additionally, to minimize the possibility of eccentric pile loading, each pile cap should include two piles driven in opposing directions with the same batter.

## *FOUNDATION AND RETAINING WALLS*

Retaining walls backfilled on only one side should be designed to resist the lateral earth pressures imposed by the soil they retain. The following recommended parameters are for walls that restrain <u>level</u> backfill:

| PARAMETER | VALUE |
|---|---|
| Active Earth Pressure * | 40 pcf |
| Passive Earth Pressure | 300 pcf |
| Coefficient of Friction | 0.45 |
| Soil Unit Weight | 130 pcf |

**Where: pcf is Pounds per Cubic Foot, and Active and Passive Earth Pressures are computed using the Equivalent Fluid Pressures.**

*** For a restrained wall that cannot deflect at least 0.002 times its height, a uniform lateral pressure equal to 10 psf times the height of the wall should be added to the above active equivalent fluid pressure. This applies only to walls with level backfill.**

The design values given above do not include the effects of any hydrostatic pressures behind the walls and assume that no surcharges, such as those caused by slopes, vehicles, or adjacent foundations will be exerted on the walls. If these conditions exist, those pressures should be added to the above lateral soil pressures. Where sloping backfill is desired behind the walls, we will need to be given the wall dimensions and the slope of the backfill in order to provide the appropriate design earth pressures. Heavy construction equipment should not be operated behind retaining and foundation walls within a distance equal to the height of a wall, unless the walls are designed for the additional lateral pressures resulting from the equipment.

The values given above are to be used to design only permanent foundation and retaining walls that are to be backfilled, such as conventional walls constructed of reinforced concrete or masonry. It is not appropriate to use the above earth pressures and soil unit weight to back-calculate soil strength parameters for design of other types of retaining walls, such as soldier pile, reinforced earth, modular or soil nail walls. We can assist with design of these types of walls, if desired.

The passive pressure given is appropriate only for a shear key poured directly against undisturbed native soil, or for the depth of level, well-compacted fill placed in front of a retaining or foundation wall. The values for friction and passive resistance are ultimate values and do not include a safety factor. Restrained wall soil parameters should be utilized the wall and reinforcing design for a distance of 1.5 times the wall height from corners or bends in the walls, or from other points of restraint. This is intended to reduce the amount of cracking that can occur where a wall is restrained by a corner.

### ***Wall Pressures Due to Seismic Forces***

The surcharge wall loads that could be imposed by the design earthquake can be modeled by adding a uniform lateral pressure to the above-recommended active pressure. The recommended surcharge pressure is 8**H** pounds per square foot (psf), where **H** is the design retention height of the wall. Using this increased pressure, the safety factor against sliding and overturning can be reduced to 1.2 for the seismic analysis.

### ***Retaining Wall Backfill and Waterproofing***

Backfill placed behind retaining or foundation walls should be coarse, free-draining structural fill containing no organics. This backfill should contain no more than 5 percent silt or clay particles and have no gravel greater than 4 inches in diameter. The percentage of particles passing the No. 4 sieve should be between 25 and 70 percent. The native soils are not free-draining, and are not acceptable for reuse as wall backfill. The later section entitled ***Drainage Considerations*** should also be reviewed for recommendations related to subsurface drainage behind foundation and retaining walls.

The purpose of these backfill requirements is to ensure that the design criteria for a retaining wall are not exceeded because of a build-up of hydrostatic pressure behind the wall. Also, subsurface drainage systems are not intended to handle large volumes of water from surface runoff. The top 12 to 18 inches of the backfill should consist of a compacted, relatively impermeable soil or topsoil, or the surface should be paved. The ground surface must also slope away from backfilled walls at one to 2 percent to reduce the potential for surface water to percolate into the backfill.

Water percolating through pervious surfaces (pavers, gravel, permeable pavement, etc.) must also be prevented from flowing toward walls or into the backfill zone. Foundation drainage and waterproofing systems are not intended to handle large volumes of infiltrated water. The compacted subgrade below pervious surfaces and any associated drainage layer should therefore be sloped away. Alternatively, a membrane and subsurface collection system could be provided below a pervious surface.

It is critical that the wall backfill be placed in lifts and be properly compacted, in order for the above-recommended design earth pressures to be appropriate. The recommended wall design criteria assume that the backfill will be well-compacted in lifts no thicker than 12 inches. The compaction of backfill near the walls should be accomplished with hand-operated equipment to prevent the walls from being overloaded by the higher soil forces that occur during compaction. The section entitled ***General Earthwork and Structural Fill*** contains additional recommendations regarding the placement and compaction of structural fill behind retaining and foundation walls.

The above recommendations are not intended to waterproof below-grade walls, or to prevent the formation of mold, mildew or fungi in interior spaces. Over time, the performance of subsurface drainage systems can degrade, subsurface groundwater flow patterns can change, and utilities can break or develop leaks. Therefore, waterproofing should be provided where future seepage through the walls is not acceptable. This typically includes limiting cold-joints and wall penetrations, and using bentonite panels or membranes on the outside of the walls. There are a variety of different waterproofing materials and systems, which should be installed by an experienced contractor familiar with the anticipated construction and subsurface conditions. Applying a thin coat of asphalt emulsion to the outside face of a wall is not considered waterproofing, and will only help to reduce moisture generated from water vapor or capillary action from seeping through the concrete. As with any project, adequate ventilation of basement and crawl space areas is important to prevent a buildup of water vapor that is commonly transmitted through concrete walls from the surrounding soil, even when seepage is not present. This is appropriate even when waterproofing is applied to the outside of foundation and retaining walls. We recommend that you contact an experienced envelope consultant if detailed recommendations or specifications related to waterproofing design, or minimizing the potential for infestations of mold and mildew are desired.

## *DRAINAGE CONSIDERATIONS*

Footing drains should be used where: (1) crawl spaces or basements will be below a structure; (2) a slab is below the outside grade; or, (3) the outside grade does not slope downward from a building. Drains should also be placed at the base of all earth-retaining walls. These drains should be surrounded by at least 6 inches of 1-inch-minus, washed rock that is encircled with non-woven, geotextile filter fabric (Mirafi 140N, Supac 4NP, or similar material). At its highest point, a perforated pipe invert should be at least 6 inches below the bottom of a slab floor or the level of a crawl space. The discharge pipe for subsurface drains should be sloped for flow to the outlet point. Roof and surface water drains must not discharge into the foundation drain system. A typical footing drain detail is attached to this report as Plate 4. For the best long-term performance, perforated PVC pipe is recommended for all subsurface drains. Clean-outs should be provided for potential future flushing or cleaning of footing drains.

As a minimum, a vapor retarder, should be provided in any crawl space area to limit the transmission of water vapor from the underlying soils. Crawl space grades are sometimes left near the elevation of the bottom of the footings. As a result, an outlet drain is recommended for all crawl spaces to prevent an accumulation of any water that may bypass the footing drains. Providing a few inches of free draining gravel underneath the vapor retarder is also prudent to limit the potential for seepage to build up on top of the vapor retarder.

No groundwater was observed during our field work. If seepage is encountered in an excavation, it should be drained from the site by directing it through drainage ditches, perforated pipe, or French drains, or by pumping it from sumps interconnected by shallow connector trenches at the bottom of the excavation.

The excavation and site should be graded so that surface water is directed off the site and away from the tops of slopes. Water should not be allowed to stand in any area where foundations, slabs, or pavements are to be constructed. Final site grading in areas adjacent to a building should slope away at least one to 2 percent, except where the area is paved. Surface drains should be provided where necessary to prevent ponding of water behind foundation or retaining walls. A discussion of grading and drainage related to pervious surfaces near walls and structures is contained in the ***Foundation and Retaining Walls*** section.

## ***LIMITATIONS***

The conclusions and recommendations contained in this report are based on site conditions as they existed at the time of our exploration and assume that the soil and groundwater conditions encountered in the test holes are representative of subsurface conditions on the site. If the subsurface conditions encountered during construction are significantly different from those observed in our explorations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. Unanticipated conditions are commonly encountered on construction sites and cannot be fully anticipated by merely taking samples in test holes. Subsurface conditions can also vary between exploration locations. Such unexpected conditions frequently require making additional expenditures to attain a properly constructed project. It is recommended that the owner consider providing a contingency fund to accommodate such potential extra costs and risks. This is a standard recommendation for all projects.

The recommendations presented in this report are directed toward the protection of only the proposed additions from damage due to slope movement. Predicting the future behavior of steep slopes and the potential effects of development on their stability is an inexact and imperfect science that is currently based mostly on the past behavior of slopes with similar characteristics. Landslides and soil movement can occur on steep slopes before, during, or after the development of property. The owner of any property containing, or located close to steep slopes must ultimately accept the possibility that some slope movement could occur, resulting in possible loss of ground or damage to the facilities around the proposed additions.

This report has been prepared for the exclusive use of Robert Peha and his representatives for specific application to this project and site. Our conclusions and recommendations are professional opinions derived in accordance with our understanding of current local standards of practice, and within the scope of our services. No warranty is expressed or implied. The scope of our services does not include services related to construction safety precautions, and 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. Our services also do not include assessing or minimizing the potential for biological hazards, such as mold, bacteria, mildew and fungi in either the existing or proposed site development.

## ***ADDITIONAL SERVICES***

Geotech Consultants, Inc. should be retained to provide geotechnical consultation, testing, and observation services during construction. This is to confirm that subsurface conditions are consistent with those indicated by our exploration, to evaluate whether earthwork and foundation construction activities comply with the general intent of the recommendations presented in this report, and to provide suggestions for design changes in the event subsurface conditions differ from those anticipated prior to the start of construction. However, our work would not include the supervision or direction of the actual work of the contractor and its employees or agents. Also, job and site safety, and dimensional measurements, will be the responsibility of the contractor.

During the construction phase, we will provide geotechnical observation and testing services when requested by you or your representatives. Please be aware that we can only document site work we actually observe. It is still the responsibility of your contractor or on-site construction team to verify that our recommendations are being followed, whether we are present at the site or not.

The following plates are attached to complete this report:

| | |
|---|---|
| Plate 1 | Vicinity Map |
| Plate 2 | Site Exploration Plan |
| Plate 3 | Test Hole Logs |
| Plate 4 | Typical Footing Drain Detail |

We appreciate the opportunity to be of service on this project. Please contact us if you have any questions, or if we can be of further assistance.

Respectfully submitted,
GEOTECH CONSULTANTS, INC.

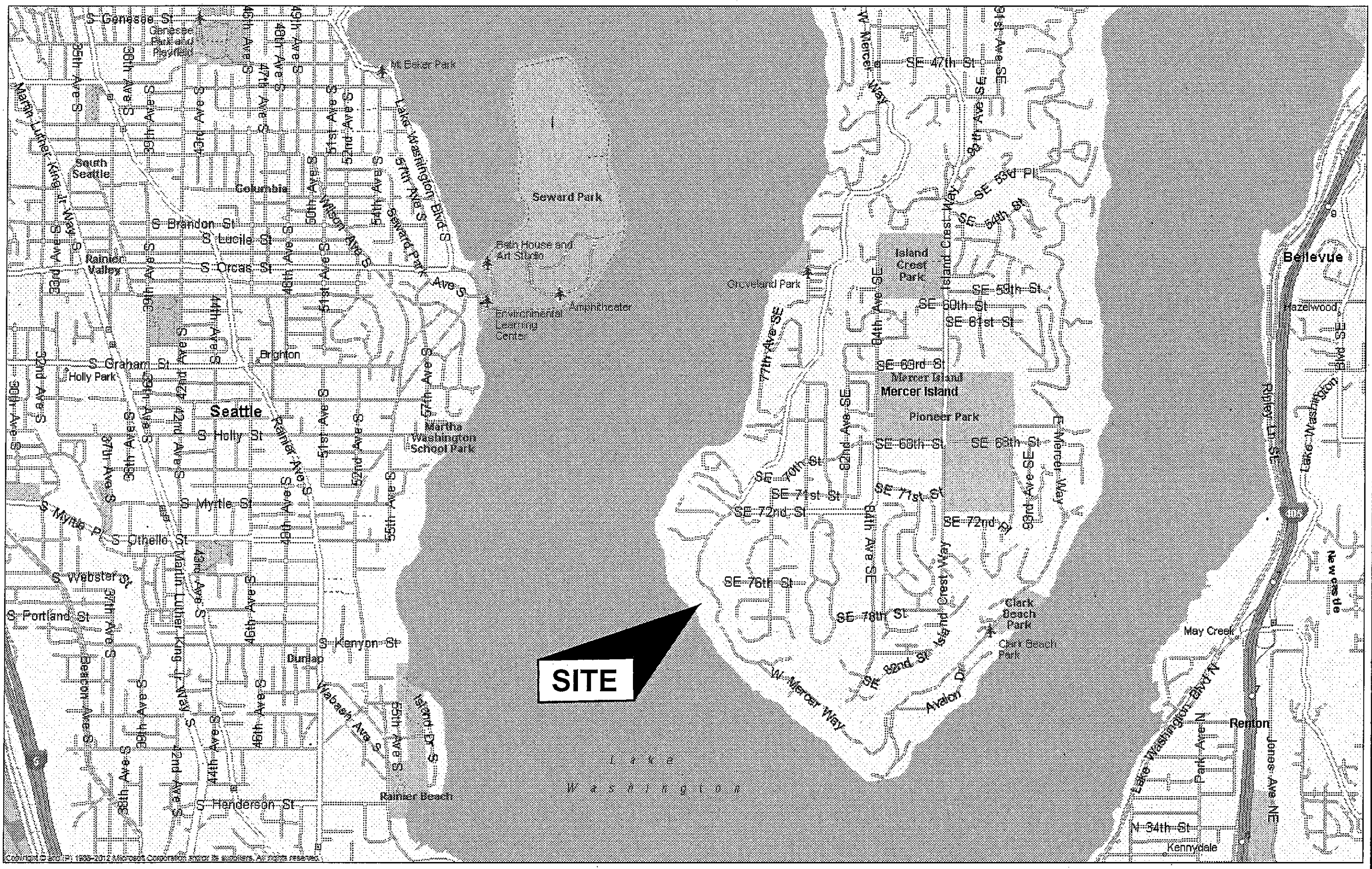
Thor Christensen, P.E.
Senior Engineer

MARC R. McGINNIS
STATE OF WASHINGTON
27845
REGISTERED
PROFESSIONAL ENGINEER

05/01/18

Marc R. McGinnis, P.E.
Principal

NORTH




(Source: Microsoft MapPoint, 2013)

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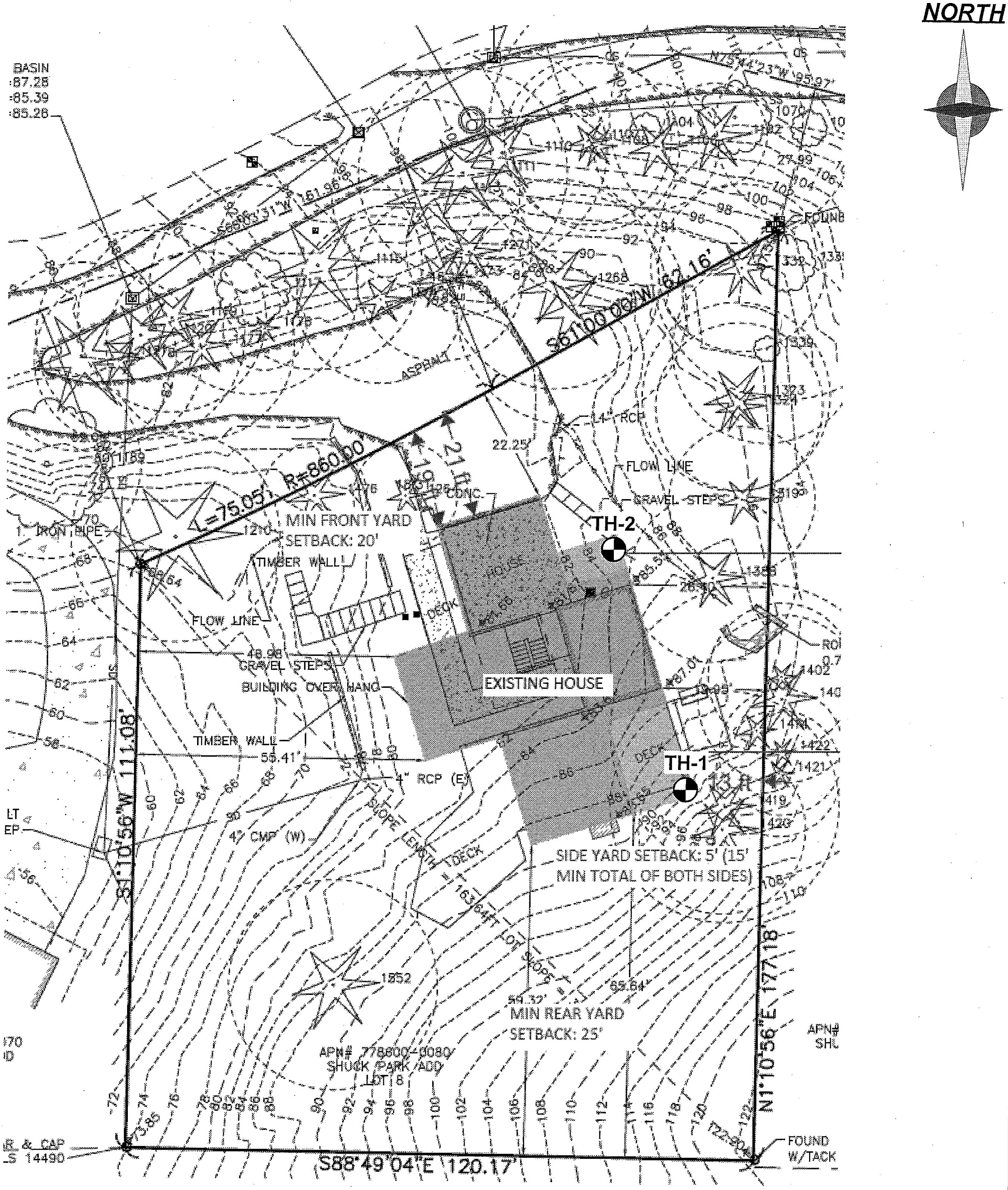
# VICINITY MAP

7653 West Mercer Way
Mercer Island, Washington

| Job No: | Date: | | Plate: |
|---|---|---|---|
| 18194 | April 2018 | | 1 |




**Legend:**

Test Hole Location

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**SITE EXPLORATION PLAN**

7653 West Mercer Way
Mercer Island, Washington

| Job No: | Date: | | Plate: |
|---|---|---|---|
| 18194 | April 2018 | No Scale | 2 |

# TEST HOLE 1

| Depth (ft.) | Moisture Content (%) | Water Table | USCS | Description |
|---|---|---|---|---|
| | | | | Topsoil |
| | | | SM | Brown silty SAND with gravel, fine to coarse-grained, very moist, loose<br>-becomes loose to medium-dense<br>-becomes medium-dense |
| | | | SW | Brown SAND with gravel, fine to coarse-grained, very moist, medium-dense |
| 5 | | | ML | Rust-brown mottled gray-brown SILT, non-plastic, very moist, medium-dense |
| 10 | | | | |

*** Test Hole terminated at 5 feet on April 17, 2018.**
*** No groundwater seepage was observed during excavation.**
*** No caving observed during excavation.**

# TEST HOLE 2

| Depth (ft.) | Moisture Content (%) | Water Table | USCS | Description |
|---|---|---|---|---|
| | | | | Topsoil |
| | | | SM | Brown silty SAND with gravel, fine to coarse-grained, moist, loose<br>-becomes gray-brown and very moist |
| | | | ML | Rust-brown mottled gray-brown SILT, non-plastic, very moist, medium-dense |
| 5 | | | | |
| 10 | | | | |

*** Test Hole terminated at 3 feet on April 17, 2018.**
*** No groundwater seepage was observed during excavation.**
*** No caving observed during excavation.**

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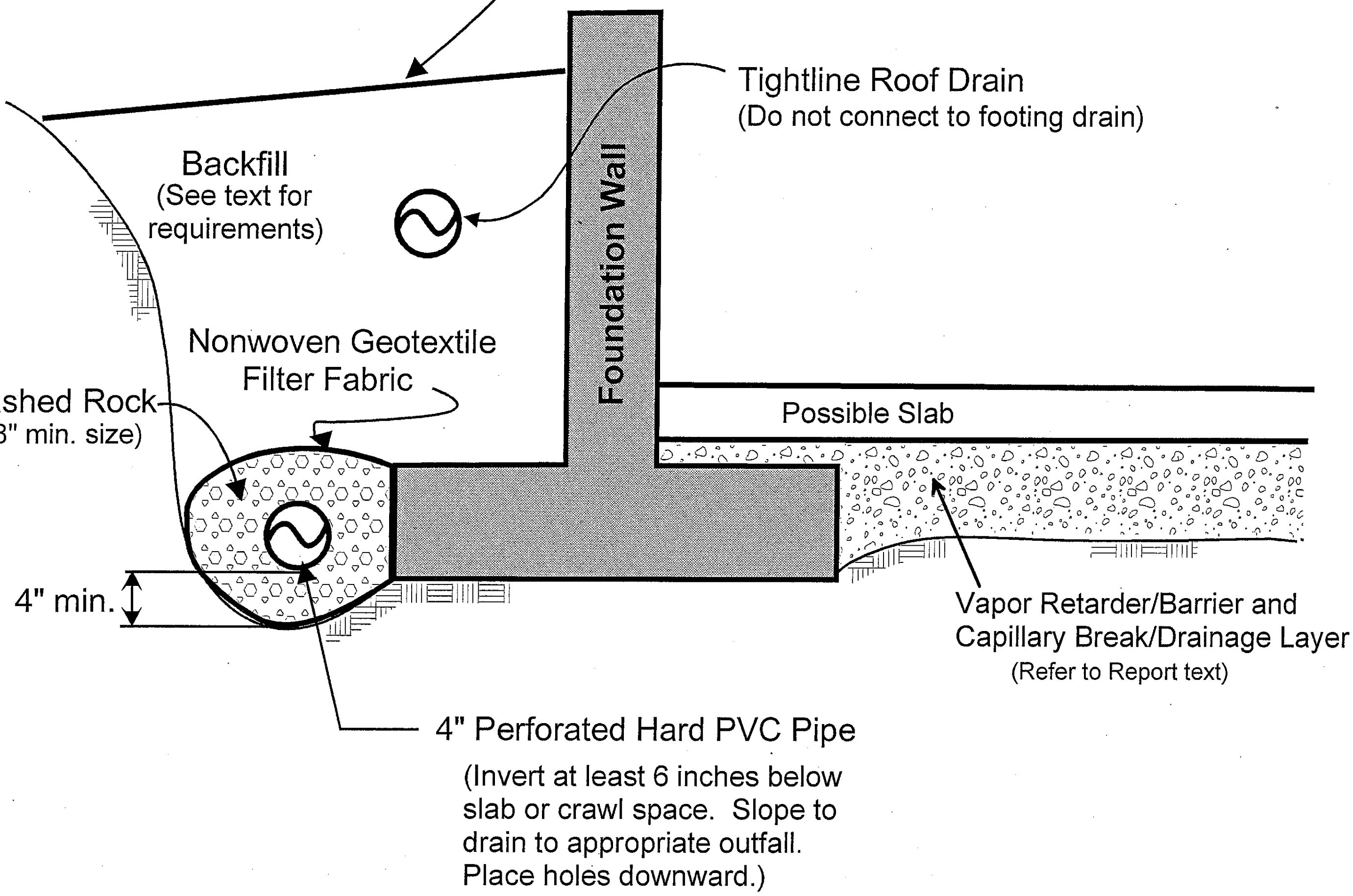
## TEST HOLE LOG

7653 West Mercer Way
Mercer Island, Washington

| Job | Date: | Logged by: | Plate: |
|---|---|---|---|
| 18194 | April 2018 | TRC | 3 |




**NOTES:**

(1) In crawl spaces, provide an outlet drain to prevent buildup of water that bypasses the perimeter footing drains.

(2) Refer to report text for additional drainage, waterproofing, and slab considerations.

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**FOOTING DRAIN DETAIL**

7653 West Mercer Way
Mercer Island, Washington

| Job No: | Date: | | Plate: |
|---|---|---|---|
| 18194 | April 2018 | | 4 |