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JN 20408

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via email: billsummers1841@gmail.com

Subject: **Geotechnical Engineering Assessment of Landslide Hazard Mitigation**
Proposed Mercer Island Treehouse Residence
5637 East Mercer Way
Mercer Island, Washington

References: *Geotechnical Engineering Study, Proposed Residence, 5637 East Mercer Way, Mercer Island, Washington*; GeoGroup NW; March 12, 2015.

Response to September 3, 2015 Geotechnical Third Party Review Letter, Proposed Residence, 5637 East Mercer Way, Mercer Island, Washington; GeoGroup NW; October 28, 2015.

Geotechnical Report Addendum, Potential Adverse Impacts to Adjacent and Downhill Properties, 5637 East Mercer Way, Mercer Island, WA 98040; GeoGroup NW; May 3, 2017.

Response to Shannon & Wilson Third Party Review, RE: Proposed Residence, 5637 East Mercer Way, Mercer Island, Washington 98040; GeoGroup NW; October 23, 2019.

Architectural Plans (The Healey Alliance AZ, June 25, 2020) and Structural Plans (Stoney Point Engineering, March 30, 2020).

Boundary and Topographic Survey, Core Design, August 31, 2020.

At your request, Geotech Consultants, Inc. has completed an independent geotechnical review of the measures that have been incorporated into the planned Mercer Island Treehouse development to mitigate the geologic hazards not only to the proposed residence, but also to the neighboring properties surrounding the site.

In order to complete this assessment, we completed the following tasks:

- Visited the site on November 3, 2020 to assess conditions on the subject property and the adjoining lots,
- Reviewed the above-referenced documents,
- Reviewed our project files for geotechnical and geologic information from previous experience on nearby sites,
- Researched the Mercer Island GIS for Critical Area mapping,
- Reviewed the Department of Natural Resources' *Geologic Information Portal* for geologic mapping of the site vicinity, and
- Reviewed the *Mercer Island Landslide Hazard Assessment* (Troost & Wisher, 2009).

Project Description

Based on the project plans, the site development will consist of a two-story residence with an east-facing daylight basement underlying approximately two-thirds of the house's footprint. This basement level will contain the garage. A new paved driveway will extend to the garage from the existing driveway that curves through the southeastern corner of the lot to serve the adjacent southern residence (#5645). The development area is constrained by an east-flowing watercourse that extends through the northern portion of the lot, and by steep slopes located along the west and south sides of the property. The planned residence will be sited in the center of the lot, where the existing ground surface slopes gently to moderately. No development, or even disturbance, is planned for of the steep slopes that rise to the west and southwest to homes along Southeast 57th Street. The provided structural plans show that significant structural considerations have been incorporated to deal with the site geologic and topographic conditions. The house to be supported on piles driven into the underlying glacially-compressed soils. Additionally, soldier pile shoring will be used to provide temporary support for the basement excavation cuts until the permanent foundation walls have been completed. Soldier piles will also be installed for the excavation to create the small motorcourt/parking area to the east of the house. These soldier piles will restrain the cuts needed into the short steep slope that rise to the neighboring southern property. The upslope (south and west) foundation walls will be extended above the surrounding ground surface to provide landslide catchment/diversion in the event of future slides moving down the neighboring steep slopes.

We expect that extensive temporary and permanent drainage will be installed as a part of this project. The provided project plans indicate that runoff from impervious surfaces in the development area will initially be collected in a detention tank, and then will be discharged at a reduced rate. The natural discharge point for this water is the watercourse that runs along the north side of the development area. All precipitation falling within the planned development area currently infiltrates into the ground to add to the flow in the watercourse.

Geologic Setting and Landslide Hazard Assessment

From our site observations, and review of topographic information provided not only in the project plans, but also on Mercer Island's GIS system, it is apparent that the subject site occupies the base of an east-trending ravine. This ravine feature starts many lots to the west, near 91st Avenue Southeast, and extends east to the old shore of Lake Washington. There are numerous similar ravines along the eastern side of Mercer Island, and they were formed largely from heavy flows of post-glacial runoff traveling down the sideslopes of Mercer Island when the last glaciers receded over 10,000 years ago. Now, this ravine serves to carry surface runoff and groundwater seepage, as well as runoff from impervious surfaces (roads, roofs, driveways, etc.) that are generally located in the same storm drainage basin. Downstream of the site, the watercourse flows through a culvert underneath East Mercer Way to continue eastward to Lake Washington.

The soft/loose upper soils found in GeoGroup NW's borings are consistent with alluvial soils that have been deposited in the base of the ravine by water flow and erosion, and potentially previous slides on the steep sideslopes of the ravine. The unconsolidated condition of these soils is evident simply from walking around the development area, where we could easily push our T-probe into the soil to its full 4-foot length with minimal effort. As verified by GeoGroup's borings, these alluvial soils are underlain by glacially-compressed soils. This is consistent with the geologic mapping of the area, which shows glacial drift or glacial outwash soils.

It was not necessary for us to cross onto the adjacent western and southwestern properties to observe the conditions on the slope. We could assess the slope conditions from the western property line of the Mercer Island Treehouse property, and from the trail in the adjacent northern Parkwood Ridge Open Space. The steep slopes rising to the west and southwest from the building site on the Mercer Island Treehouse property are 90 to 100 feet in height. Based on available topographic information from the *Boundary and Topographic Survey*, and our on-site measurements with a hand-held clinometer, the steep slopes within the property boundaries are inclined at approximately 50 percent. However, the heavily-treed, steeper slope to the west southwest is inclined at 65 to 75 percent. The slopes to the west and southwest of the site are heavily treed with large evergreen trees. We were able to observe the steep slope west and southwest of the site over its full height. Based on anecdotal information provided, and review of the *Mercer Island Landslide Hazard Assessment*, there has been previous landsliding behind the adjacent western homes, likely near the top of the steep slope. There were no obvious indications of recent instability that we could observe. While deciduous trees on the slope displayed their typical curved trunks, there were no signs that this curvature was related to slope movement. The evergreen trees, which will typically grow with straight trunks, did not display the multiple curves in their trunks that would be indicative of deeper slope movement. In fact, there are some very large evergreen trees on the slope that have no curvature to their trunks at all. We did observe some of the typical "pistol butting" of the base of some of the trees. This is typical on steep slopes, where seedlings can be tipped sideways by shallow soil creep, falling branches, etc. before they are bigger and deeply rooted. This causes a curve or "pistol butt" in the base of the trunk, while the remainder of the evergreen tree then grows straight upward. We also saw stumps of old growth evergreen trees in, and around, the planned development area, a further testament to the deep stability of the area.

It is important to realize that the soil conditions comprising the steep slopes rising to the west and southwest of the site are substantially different, and more stable, that those found in the development area in the base of the ravine. The geologic mapping found on the *Geologic Information Portal* confirms that the upland area along Southeast 57th Street, as well as the steep slopes below the homes on that street, is underlain by Glacial Till. This soil is a glacially-compressed mixture of gravel, silt, and fine-grained sand. It is cemented, and is often referred to as hardpan. Glacial Till has a very high internal strength, often allowing tall vertical banks to stand for many, many years with only limited spalling off the face of the bank. This is evident throughout the Pacific Northwest not only in marine bluffs, but also in manmade excavations, such as those made for roads. Our observation of the conditions on the steep slopes extending west and south of the development site showed established underbrush and numerous mature trees on the slopes. Glacial Till soils are not susceptible to deep-seated instability, even on the steeply-inclined natural slopes around the site.

That is not to say that landslides cannot occur on steep slopes underlain by Glacial Till. Over time, which can take 30+ years, the near-surface few feet (typically 2 feet) of soil naturally weathers and loosens by freeze-thaw effects. This loosened layer, combined with the topsoil and duff that can accumulate, periodically slides down a steep slope, usually following extended wet weather. Unfortunately, man's actions (improper discharge of runoff, placement of uncontrolled fill on or near a slope, or leaking utilities) can increase the likelihood, or be the sole cause, of landslides in these soil conditions. We have been associated with numerous slides on Mercer Island steep slopes that were directly related to improper development practices used when properties were developed above steep slopes. These often revolved around the common, and improper, practice of placing uncompacted and unretained soil over steep slopes to create flatter areas for yards and landscaping. Our review of the *Mercer Island Landslide Hazard Assessment* confirms that there have been documented slides on the steep slopes to the west and south of the planned

development, and that is no surprise. However, for the reasons discussed above, we expect the natural slides to have been relatively localized and confined to the near-surface few feet of weathered soil. Larger slides, especially those that may have affected rear yards, decks, landscaping, etc. of the upslope homes, likely involved improperly placed or unretained fill.

The undersigned project engineer has also been associated with the recent slide that affected the eastern slope below East Mercer Way at 5368 East Mercer Way, approximately 400 feet to the east of the Mercer Island Treehouse property. This slide occurred on November 28, 2020. Similar to the slides discussed above, this recent landslide was shallow, affecting uncontrolled fill and weathered soils above the dense, glacially-compressed soil. It appears to have been triggered by excessive water within the looser soils.

Geotechnical Conclusions

Development of the subject property, while challenging, can be accomplished safely, without risk to surrounding properties. Anyone familiar with development on Mercer Island is aware of numerous sites that have been successfully developed in, and near, ravines and steep slopes. Our firm has been involved with many such projects over its 34+ year history. The geotechnical measures of shoring, slide catchment, and foundation piles recommended by GeoGroup NW which have been included in the project are appropriate to protect the planned residence and its occupants from the geologic hazards associated with the site.

The geotechnical measures incorporated into the plans at the recommendation of GeoGroup NW are appropriate to prevent adverse impacts to the stability of the site and the surrounding properties. These measures are significant and costly, but are needed to accommodate the geologic constraints of the property and surrounding lots. The planned shoring is necessary to support the unconsolidated, loose soils for the excavation of the house. The loose soils in the building area provide no significant lateral support for the glacially-compressed materials that comprise the steep slopes to the west and south. Removal of the loose sediments would not cause instability in the glacially-compressed soils of the steep slopes. Even so, the excavation shoring that will be installed to facilitate the excavation of the below-grade portion of the structure will provide lateral support for the base of the steep slopes that exceeds what currently exists. This shoring will also minimize the amount of excavation necessary for the project by preventing the need for temporary cut slopes extending outside the footprint of the structure.

Including the slide catchment wall into the design of the house will provide protection against damage that could result from slide debris reaching the structure. Also, by eliminating the need for a separate, free-standing wall, the amount of site disturbance and excavation will be reduced.

The potential for future shallow instability on the steep slopes that extend up to the neighboring west and south properties will not be increased by the planned development. The slopes are comprised of competent, glacially-compressed soils. The trees and underbrush on these slopes will remain, and no excavation into the steep slopes themselves will occur. Again, as discussed above, support for the loose soils at the bottom of the slope will be improved by the shoring and permanent below-grade walls of the new residence.

The planned development will not pose a risk to the neighboring houses. The excavation for the new house will be quite distant from all neighboring houses, even the one immediately south at #5645. These structures do not count on lateral support from the soft/loose soils that will be removed for the new house's construction. From a practical standpoint, if these houses were, in fact, supported by the loose/soft soils at the base of the slope, they would have long ago

experienced excessive settlement and lateral movement to the point that they would require foundation underpinning and stabilization measures. Driving of the small-diameter foundation piles to be used for the new house does not cause strong ground vibrations and will not cause settlement in the foundations of the neighboring homes.

The subsurface drainage system that will be installed for the house will not decrease the stability of the steep slopes. Removal of water from soil, especially near slopes, does not have a negative impact on slope stability. In many cases, the removal of water will actually improve stability of slopes.

Under the Mercer Island Municipal Code, the subject property meets the criteria for the following geologic hazards: Potential Landslide Hazard, Steep Hazard, Seismic Hazard and Erosion Hazard.

Potential Landslide Hazard: Under Mercer Island Code (MICC) 19.07.160.C.2, a prescriptive minimum buffer of 25 feet is to be maintained from Shallow Landslide Hazard areas, and 75 feet from Deep-seated Landslide Hazard areas. Considering the competent glacial till soils that comprise the steep slopes to the west and southwest of the site, and the lack of evidence of deep-seated slides, it is our professional opinion that this slope would be a Shallow Landslide Hazard Area.

The planned residence will extend into the minimum prescriptive buffer. Considering the measures that have been included in the home design, a buffer is not necessary to mitigate the landslide hazard to the site or the neighboring properties. The excavation for the new home will not adversely impact the stability of the surrounding properties, as it will be shored with substantial engineered soldier pile walls that will maintain temporary support for the excavation at the toe of the steep slope. Also, the permanent basement walls will provide appropriate long-term support that will, in fact, provide more stability for the slope's toe than the loose soils currently do. The hazard to the occupants of the planned Mercer Island Treehouse residence from the buffer reduction will be mitigated by constructing the upslope walls of the house to catch or deflect landslide debris from potential future slides on the steep slopes.

Steep Slope Hazard: Under MICC 19.07.160.C.2.a, a minimum prescriptive buffer equal to the height of the steep slope, not to exceed 75 feet, shall be applied to the top and toe of the steep slope. Considering the height of the steep slope to the west and southwest, the 75-foot maximum prescriptive buffer would apply.

The planned residence will encroach into this prescriptive buffer, extending to the toe of the steep slope areas located within the site boundaries. However, from a geotechnical standpoint, this buffer encroachment will not adversely impact the stability of the steep slopes, for the same reasons discussed above. The excavation will be temporarily shored with an engineered soldier pile wall that will maintain support for the toe of the steep slope, and the permanent basement walls will provide increased lateral support for the toe of the steep slope. These measures will prevent adverse impacts to the stability of the steep slopes within the site, and on the surrounding properties.

Seismic Hazard: MICC 19.07.160.D addresses development considerations for Seismic Hazard areas. There is no information indicating that the site lies on, or near, an active fault. As a result, no buffer associated with the Seismic Hazard designation is required.

However, the loose soils underlying the groundwater table could undergo liquefaction (soil strength loss) in the event of strong ground shaking during a large earthquake. This is a typical risk associated with sites located in ravines or valleys, and along lake shores. The Seismic Hazard related to potential foundation bearing loss under shallow foundations from seismic liquefaction will be mitigated for this project by the use of deep pile foundations that will be embedded into dense to very dense soils that are not liquefiable. This will maintain vertical support for the piles in the event of an earthquake, and the grade beams that will interconnect the piles will provide added protection against foundation collapse.

Erosion Hazard: Under the criteria of the Mercer Island Code, much of the island falls under the designation of an Erosion Hazard area. This is based mostly on the presence of silty, fine-grained soils, and ground that slopes at 15 percent or more. Not only the site, but all of the adjoining properties, including those upslope to the west and southwest, fall under the classification of Erosion Hazard areas.

MICC 19.07.160.E requires that:

1. All development proposals within erosion hazard areas shall comply with Chapter 15.09 of the MICC for the Storm Water Management Program, and
2. The planned development or activity within an erosion hazard area cannot increase the potential for instability on or off the site.

To satisfy condition 1, during the design and permitting process, the City of Mercer Island will require that the project meets the requirements of the stormwater code. We expect that this will include preparing a detailed Temporary Erosion and Sedimentation Control (TESC) plan, which is a requirement for any project located within an Erosion Hazard area. Additionally, the City will require that the site stormwater design complies with their stormwater code.

For condition 2, as discussed above, in the Landslide Hazard and Steep Slope Hazard sections, the proposed project will incorporate measures that will prevent an increase in the potential for instability both on, and of, the site.

In their October 23, 2019 letter, GeoGroup NW provided the “statement of risk” required by the City of Mercer Island code (MICC 19.07.160.C.3) for geologically hazardous areas. This statement, which addresses risks to both the site and the adjacent property, is appropriate, and is consistent with statements of risk we have had to provide in our company’s 34+ years of geotechnical engineering on Mercer Island. From a geotechnical standpoint, an alternative statement of risk,

> “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”

would also apply to the project, and technically be more appropriate. However, this does not change the conclusions we have reached about the appropriateness of the planned development and the mitigation measures that will be included.

From a geotechnical standpoint, it is worth noting that the upslope properties actually pose more of a hazard to the subject property than the other way around. The homes along the top of the steep slope are well within the minimum prescriptive buffer for steep slope hazard areas, and were constructed well before the implementation of Critical Area codes on Mercer Island. Past practices, such as placement of uncontrolled fills and/or walls on or near steep slopes for yards and

landscaping, would not be allowed under current codes. Improper fill placement and grading, excessive clearing or poorly-managed tree removal, or ineffective or malfunctioning drainage systems above a steep slope increase the potential for future slope movement. While the hazard of potential future slope movement has been addressed for the planned Mercer Island Treehouse residence by the planned slide catchment wall to be incorporated into the house, it is still the responsibility of upslope property owners to avoid increasing the potential for instability on the steep slopes.

Please contact us if there are any questions regarding this letter.

Respectfully submitted,

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12/03/2020
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