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LIU & ASSOCIATES, INC.

Geotechnical Engineering | Engineering Geology | Earth Science

September 1, 2011

Mr. William Gartz
7703 West Mercer Way
Mercer Island, WA 98040

Dear Mr. Gartz:

Subject: Geotechnical Investigation
Soldier Pile Retaining Wall
Gartz Residence
7703 West Mercer Way
Mercer Island, Washington
L&A Job No. 11-059

INTRODUCTION

The subject residence is a waterfront property located at the above address on the west shore of Lake Washington, with its general location shown on Plate 1 – Vicinity Map, attached hereto. An existing timber retaining wall on the property above the lake shore is failing due to wood decaying. We understand that you plan to replace this timber wall with a soldier pile retaining wall a few feet behind the failing timber wall, with the wall kept to no more than 6 feet tall. (4 TMP.)

At your request, we have completed a geotechnical investigation for the design of the proposed soldier pile wall. Presented in this report are our findings of the subsurface conditions in the area of the proposed soldier pile wall and design and construction recommendations for this wall.

SITE CONDITIONS

Surface Condition

The subject residence is situated on a steep, southwesterly-declining slope just above Lake Washington. As shown on Plate 2 – Partial Site and Soldier Pile Wall Layout Plan, the slope

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behind (west of) the house on the property descends at an average grade of about 50 to 55 percent towards the lake. Lining the lake shore at water's edge is an existing rockery wall about 5 to 7 feet tall. Behind the rockery wall near the bottom of the slope is a timber retaining wall about 3.5 to 4.0 feet tall. This timber wall has deteriorated from wood decay and is tilting slightly outward. The slope between the back of the house and this timber wall has been graded locally and lined with concrete block walls and timber walls to support patios and small grassed yards at the upper level and a dirt walkway down the slope to a boat dock on the lake side. The slope is mostly covered with grass and with thick brush behind the rockery wall.

Geologic Setting

The Geologic Map of Mercer Island, Washington, by Kathy G. Troost and Aaron P. Wisher, published in October 2006, was referenced for the geologic and soil conditions of the subject property. According to this publication, the surficial soil units at and in the vicinity of the subject property are mapped, from upper to lower elevations on the slope, as pre-Olympia glacial till (Q_{pogt}), pre-Olympia fine-grained glacial deposits (Q_{pogf}), pre-Olympia coarse-grained deposits (Q_{poc}), with the Pre-Olympia coarse-grained overlain by lake deposits (Q_l) along the edge of the lake.

The pre-Olympia glacial till, pre-Olympia fine-grained glacial deposits and pre-Olympia coarse-grained deposits had been over-ridden by glacial and are normally of high shear strength and quite stable in confined situation. Where exposed on slopes or man-made cuts devoid of vegetation cover, the weaker weathered soils overlying the fine-grained glacial deposits may be saturated and eroded during periods of prolonged heavy rainstorms. Progressive erosion may cause mudslides to occur on the steep slope.

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Soil Condition

The subsurface condition in the area of the proposed soldier pile wall was explored with one test boring drilled with a portable drill rig to 18.0 feet deep on August 10, 2011. The location of this test boring, at about 6.0 feet behind the existing timber wall, is shown on Plate 2.

Soil samples obtained from the test boring were visually classified in general accordance with United Soil Classification System, a copy of which is presented on Plate 3. A geotechnical engineer from our office was present during the exploration, who examined the soil and geologic conditions encountered and completed logs of test borings. Detailed descriptions of the soils encountered during site exploration are given in test boring log presented on Plate 4.

Standard Penetration Tests were conducted, in accordance with ASTM D-1586, in the bore holes using a standard split-spoon sampler of 2-inch outside diameter, driven with a 140-pound hammer that was raised and released for a 30-inch free fall. The number of blows required to advance the sampler a given distance is an indication of the density for granular soils or the consistency for cohesive soils. The sampler was advanced 18 inches and the total number of blows for the last 12 inches were recorded on the boring logs as the N-values of the Standard Penetration Tests.

The test boring encountered a layer of loose organic topsoil, about 14 inches thick. Underlying the topsoil is a layer of weather soil of loose silty fine sand with a trace of gravel, about 2.2 feet thick. This weathered soil is underlain by a layer of disturbed soil of gray, loose, fine to medium sand with a trace to some gravel, with occasional wood fiber mixed in, about 7.5 feet thick. This disturbed soil appeared to be earlier slide debris. Underlying the disturbed soil is a gray deposit of medium-stiff to very-hard, fine sandy to clayey silt.

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Groundwater Condition

Groundwater was not encountered in the test boring drilled in the area of the proposed soldier pile wall despite that it was extended below the adjacent lake water level. The surficial weathered soil and the disturbed soil are of moderately-high permeability and would allow some storm runoff to seep into the ground, while the underlying silt deposit is practically impervious and would perch water infiltrating into the ground. The perched groundwater would flow laterally down-gradient along the surface of the underlying silt deposit. Where the silt deposit is exposed, seepage of groundwater may emerge out of slopes and cause soil in and above the seepage zones to erode and slough.

GEOLOGIC HAZARDS AND MITIGATION

According to the Erosion Hazard Assessment Map of Mercer Island, the Landslide Hazard Assessment Map of Mercer Island, and the Seismic Hazard Assessment Map of Mercer Island, all by Kathy Troost and Aaron P. Wisher, published in 2009, the subject property is mapped in erosion, landslide and seismic hazard areas. Several previous landslides were also mapped on and in the vicinity of the subject property. The proposed soldier pile wall should enhance stability of the slope above it. To mitigate erosion hazards, vegetation cover on the slope should be preserved and maintained. Concentrated stormwater should not be discharged uncontrolled onto the slope within the property. Stormwater over impervious surfaces, such as roofs and paved driveway, should be captured by underground drain line system connected to roof downspouts and to catch basins in paved driveway. Water collected by such drain line system should be tightlined to discharge into a storm sewer. These requirements within the subject property appear to have been met.

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Exposed ground devoid of vegetation or disturbed by construction of the soldier pile wall should be re-vegetated as soon as possible. The re-vegetated areas should be covered with clear plastic sheets as required and protected from erosion until the vegetation is fully established. The construction of the proposed soldier pile wall should also enhance the stability of the steep slope behind the house.

SOLDIER PILE WALL DESIGN RECOMMENDATIONS

Type of Wall

The new retaining wall, to be constructed to replace the failing timber wall, is to be a cantilever soldier-pile-and-timber-lagging wall. The alignment of this wall, shown on Plate 2, will generally follow and just below the El. 80 feet contour line, with the top of the wall set at El. 79.5 feet. A new walkway will be graded on the slope, leading from the bottom of the existing concrete stairs at the south corner of the house and zigzagging down to a to be constructed new deck at the edge of the lake. The last leg of the walkway and the deck will lie in front of the new soldier pile wall. As shown on Plate 5 – Elevation View of Soldier Pile Wall, with the top of the new deck to be set at El. 74.0 feet and the finish subgrade under the deck cut down to about El. 73.5 feet, the soldier pile wall will stand at 6 feet maximum directly behind the new wood deck.

Design Soil Pressures

A typical section of the soldier pile wall and the sloping ground in front and behind the wall is shown on Plate 6. The soldier pile wall should be designed for active soil pressure pushing the wall downhill and resisted by passive soil pressure over pile toe embedment. The surficial soil on the slope above the soldier pile wall is likely to compose mostly of disturbed soil or old slide debris. For calculation of active soil, we recommend an unit weight (γ) of 110 pcf and an angle of internal friction (ϕ) of 30^0 be used for the soil above the wall. The soil in front of the wall

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should compose of some disturbed soil overlying stiff to very hard clayey silt. For calculation of passive soil pressure, we recommend an unit weight (γ) of 120 pcf and an angle of internal friction (ϕ) of 34^0 on average be used.

The calculations of active and passive soil pressures for the design of the soldier pile wall are shown on Plates 6 and 7, based on NavFac Design Manual 7.2. We recommend an active soil pressure of 55 pcf EFD (equivalent fluid density) and a passive soil pressure of 215 pcf be used for the design of the soldier pile wall. The active soil pressure should be applied on one pile spacing above and on one pile diameter below the excavation line. The passive soil pressure should be applied on the lesser of one pile-spacing and 2.0 pile-diameters. The timber lagging boards may be designed for one half of the above recommended active soil pressure taking into account the effect of soil arching between the piles. The soldier pile wall should be designed for a factor of safety of at least 1.5 against sliding failure and at least 1.7 against overturning failure.

CONSTRUCTION OF SOLDIER PILE WALL

Soldier piles should be installed by setting steel beams in drilled holes and filling the holes with structural concrete of at least 2,000 psi compressive strength at 28 days. Slurry drilling method and/or steel casing should be used if soil caving condition is encountered in hole drilling to minimize ground loss. Slurry mix and slurry contaminated water should be stored in pits or containers and kept from flowing into the lake. Groundwater in drilled holes, if encountered, should be baled out to no more than one inch accumulation at bottom of the holes prior to filling holes with structural concrete.

(Driven H-Pile alternate selected)

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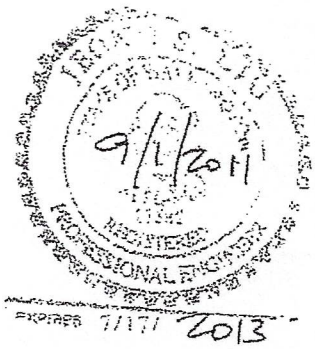
EROSION MITIGATION

Timber lagging boards should be shimmed to leave a 1/4 inch gap between boards and a non-woven filter fabric liner tacked onto the back of the boards to allow water to flow through but keep soil in place. Shrubs should be planted in front of the soldier pile wall wherever possible to absorb water flowing out of the soldier pile wall and minimize erosion.

Exposed and disturbed ground on the slope from construction work should be hydroseeded for erosion protection. The seed mixture should consist 40% Kentucky Bluegrass, 30% Creeping Red Fescue and 30% Perennial Rye. The mixture shall contain sufficient mulch such that it can bond with surficial soil to provide temporary erosion protection until the seeds are germinated and fully established.

CLOSURE

We are pleased to be of service to you. Please contact us if you have any questions regarding this report or need further consultation.



Yours very truly,
LIU & ASSOCIATES, INC.

J. S. (Julian) Liu, Ph.D., P.E.
Consulting Geotechnical Engineer

Seven plates attached

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BORING NO. B-1

Logged By: JSL 8/10/2011 Ground Elev. ±

Depth ft.	USCS	Soil Description	Sample Type	Sample No.	(N) Blows/ ft.	W %	Other Test
	SM	Dark-brown to brown, medium-dense, silty fine SAND, trace fine roots, slightly moist to dry	SS	1	11		
	SM	Gray, loose, silty fine SAND, trace gravel, slightly moist					
5	SP	Gray, loose, fine to medium SAND, trace to some gravel, slightly moist (SLIDE DEBRIS?)	SS	2	5		
10	ML	Gray, medium-stiff, fine sandy to clayey SILT, massive, slightly moist to dry (fresh LAWTON CLAY)	SS	3	4		
		- Hard drilling @ 12.0 ft, trace gravel					
15		- Same, becomes HARD	SS	4	50/5"		
		- Water added@ 15.5 ft to facilitate drilling					
		- Becomes VERY HARD	SS	5	50/4"		
20		Test boring terminated at 18.0 ft, groundwater not encountered.					
25							

LEGEND: SS - 2" O.D. Split-Spoon Sample
ST - 3" O.D. Shelby-Tube Sample
B - Bulk Sample

GROUNDWATER: Seal
Water Level
Observation Well Tip

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BORING LOG
BILL GARTZ RESIDENCE
7703 WEST MERCER WAY
MERCER ISLAND, WASHINGTON

JOB NO. 11-058 | DATE 8/10/2011 | PLATE 4

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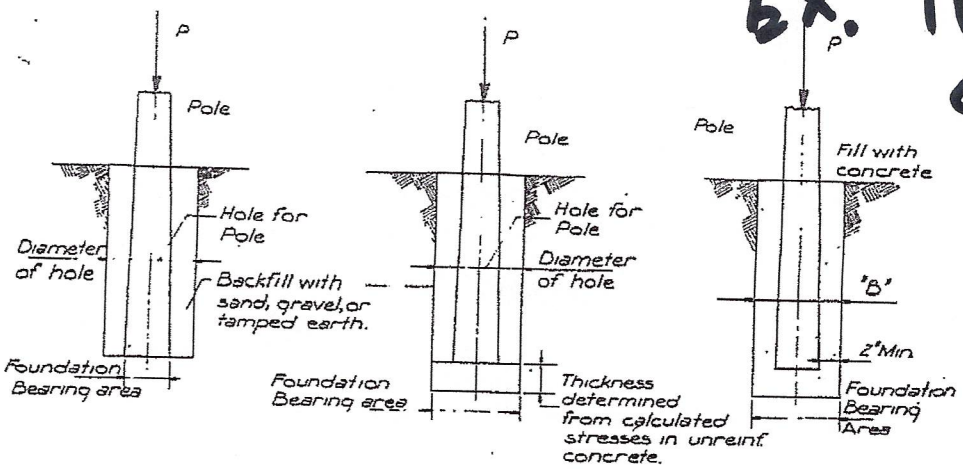

FIGURE 4 FIGURE 5 FIGURE 6

FOUNDATION DETAILS

experience in average soils and research into the actions of piles all indicate that skin friction of the soil against the sides of the pole actually will support a major portion of the vertical load on the pole.

4. METHOD OF DETERMINING EMBEDMENT:

A most important element in the design of pole type structures is the method of providing fixity at the base of the pole, where it enters the ground. Based on Rankine's method, the formula for embedment d for a moment on a pole is $d = \sqrt[3]{\frac{12\,M}{Bp}}$ or, where the distance H is relatively large, so that it contributes to the moment at the base but effects the shear only slightly,

$$d = \sqrt[3]{\frac{12\,HP}{Bp}}$$

d = depth of embedment in feet
P = applied horizontal force on pole in pounds.
H = height above ground in feet where force P is applied
B = diameter of post or concrete casing transferring lateral pressures to ground (in feet)
p = allowable passive soil pressure in pounds per square foot per foot of depth.

Conditions for this formula are shown in Figure 7. It assumes that the portion of the pole buried in the ground acts as a rigid body. This formula

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(Ref.)